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ABSTRACT

The lessons and test which comprise this document were used in two experiments concerning the effects of discovery and expository modes of presentation on retention and transfer. The methodology and results of the experiments are briefly summarized. Eight lessons are included: (1) two introductory lessons; (2) three lessons in the expository mode, one on triangles and two on quadrilaterals; and (3) three lessons in the discovery mode, one on triangles and two on quadrilaterals. Also included is a 28-item multiple-choice test dealing with concepts presented in the lessons on quadrilaterals. (Author/DT)

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Practical Paper No. 13

LESSONS ON SELECTED GEOMETRY CONCEPTS WRITTEN IN EXPOSITORY AND DISCOVERY MODES OF PRESENTATION AND A TEST OF CONCEPT MASTERY

By

Joseph A. Scott

U.S. DEPARTMENT OF HEALTH EDUCATION & WELFARE NATIONAL INSTITUTE OF EDUCATION

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Report from the Conditions of Learning
and Instruction Component of Program 1

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and Joel R. Levin
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Center for Cognitive Learning
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ABSTRACT

The lessons and test which comprise this paper were used in two experiments which studied the effects of discovery and expository modes of presentation on retention and transfer. The methodology and results of the experiments are briefly summarized. Eight lessons are included: (a) two introductory lessons; (b) three lessons in the expository mode, one on triangles and two on quadrilaterals; and (c) three lessons in the discovery mode, one on triangles and two on quadrilaterals. Also included is a 28-item multiple-choice test dealing with concepts presented in the quadrilateral lessons.

INTRODUCTION

Although various definitions of "discovery" and "expository" methods of teaching have been offered by psychologists (cf., Scott, 1970, Ch. 2), the discovery and expository lessons contained in this paper use methods of presentation which conform to Worthen's (1968) definitions of these terms. Worthen defined discovery and expository teaching in terms of the presentation sequence of stimulus materials. Discovery teaching was defined by him as "a method in which verbalization of each concept or generalization is delayed until the end of the instructional sequence by which the concept or generalization is to be taught" (p. 3). Expository teaching was defined as "a method in which the verbalization of the required concept or generalization is the initial step in the instructional sequence by which the concept or generalization is to be taught" (p. 3).

The materials which comprise this paper were used in two experiments which compared the effects of discovery and expository methods of teaching. Advocates of the discovery method have suggested that concepts learned by this method are remembered better than concepts learned by an expository method. Further, they have suggested that students who experience a discovery method of teaching not only learn the material being taught, but acquire a different approach to learning which can transfer to new situations. To test these claims, experiments were carried out which (a) compared the effects of discovery and expository methods on retention, and (b) tested whether teaching one set of concepts by either a discovery or an expository method influenced the learning of a second set of concepts.

To compare the effects of discovery and expository methods of presentation on retention, four "quadrilateral" concepts (quadrilateral, rhombus, parallelogram, and trapezoid) were presented in lessons written in either a discovery or an expository mode. The learning of the quadrilateral concepts required knowledge of prerequisite concepts such as line segment and angle. The prerequisite concepts were presented in two introductory lessons.

The concepts taught in both the introductory and the quadrilateral lessons are frequently introduced in sixth-grade textbooks and were, therefore, thought to be appropriate for the sixth graders who took part in the experiment. Great care was taken to insure that the reading level of the materials was appropriate for the average sixth grader. While students studied the lessons, proctors were available to answer any questions regarding the meaning of difficult words. Few such questions were raised. The reading level was, therefore, believed to be well-chosen.

Knowledge of the concepts was tested by a multiple-choice test which is included in this paper. Since it was of interest to compare the retention of the concepts by the discovery and expository groups, children were tested either 1, 11, or 21 days after they studied the lessons. The multiple-choice test administered was a revision of a test developed by Frayer (1970). A completion-type test was embedded in the lessons themselves to focus the attention of both the expository and discovery groups on the types of questions which would be asked in the multiple-choice test. Production and multiple-choice test items were matched in terms of the number and nature of the questions dealing with each concept.

Results of the study showed that the materials presented in the discovery mode produced the greatest long-term retention, with the test scores of subjects receiving these materials actually increasing over the 21-day period. Test scores of subjects who received the materials presented in the expository mode decreased over the 21-day period.

To determine whether practice in learning from material presented in either the discovery or expository mode would affect new learning in one of these modes, two sets of concepts were presented. First, six "triangle" concepts (triangle, equilateral triangle, isosceles triangle, acute angle triangle, right angle triangle, and obtuse angle triangle) were presented. The triangle and quadrilateral concepts were presented to different groups of children in four lesson sequences: discovery-discovery, expository-expository, discovery-expository, and expository-discovery.

The hypothesis was that students who learned both sets of concepts by the same instructional method would learn the second set of concepts better than students who learned the sets of concepts by different methods. Higher performance would result from practice in learning by the particular instructional method. To test the hypothesis, mastery of the second set of concepts (the quadrilateral concepts) was assessed by administering the multiple-choice test immediately after completion of the lessons. Results showed that knowledge of the quadrilateral concepts did not differ for the various sequences of discovery and expository modes of presentation. Thus, practice in learning by a particular instructional method did not facilitate learning.

The lessons and the tests used in the two experiments which have been described are included in this paper. The lessons are almost entirely self-sufficient. Services of an instructor or proctor are needed only to read the instructions and the word list and to assist students who have difficulty reading particular words or items. The content of the lessons and test are outlined below.

Introductory Lessons

The introductory lessons present concepts which are prerequisite to learning triangle and quadrilateral concepts. The lessons have a modified linear programming format which requires the student to respond to each item. Immediate feedback is provided for each item. The material contained in the introductory lessons is intended to be comprehensive, so that students may be able to understand the lessons even if they have had no prior training in geometry. The concepts presented in each introductory lesson are as follows:

Introductory Lesson I--point, line segment, line, ray, angle, right angle, acute angle, and obtuse angle.

Introductory Lesson II--open curve, closed curve, simple closed curve, plane, solid, polygon, intersect, parallel, opposite sides, and equal length.

Expository Lessons

In the expository lessons the name of the concept is given, followed by a definition which points out the relevant attributes of the concept. This is followed by a series of figures, each accompanied by a statement indicating whether or not the figure is an example of the concept, why it is or is not, and what the attributes of the figure are. No overt response is required

of the student while studying the lessons. The content of each expository lesson is as follows:

Triangle Lesson--triangle, equilateral triangle, isosceles triangle, acute angle triangle, right angle triangle and obtuse angle triangle.

Quadrilateral Lesson I--quadrilateral, rhombus, and completion-type tests for quadrilateral and rhombus.

Quadrilateral Lesson II--parallelogram, trapezoid, and completion-

Discovery Lessons

In the discovery method of presentation the concept is introduced by a general statement giving the concept name and telling the student that the following figures will help him to learn the concept. This statement is followed by a series of figures. The student is given instructions to examine these figures carefully, noting their likenesses and differences. The figures are accompanied by questions which encourage the student to focus on certain attributes of the figures. The series of figures is followed by questions which ask the student to identify the figures which are alike, and how those figures are alike. Feedback is provided for these questions. Finally the concept name is stated again, followed by a definition which points out the relevant attributes of the concept.

The examples used in the expository and the discovery lessons are precisely the same. Thus, the number, sequence, and ratio of positive to negative examples of the concept are the same for both methods of presentation. The content of each discovery lesson is as follows:

Triangle Lesson--triangle, equilateral triangle, isosceles triangle, acute angle triangle, right angle triangle, and obtuse angle triangle.

Quadrilateral Lesson I--quadrilateral, rhombus, and completion-type tests for quadrilateral and rhombus.

Quadrilateral Lesson II--parallelogram, trapezoid, and completion-type tests for parallelogram and trapezoid.

Tests of Geometry Knowledge

The items for both the completion-type test and the multiple-choice test were taken from tests developed by Frayer (1970). Five types of items were used, testing knowledge of attribute examples, concept examples, concept nonexamples, relevant attributes, and concept definitions. The two tests were parallel in content, item types, and number of items, but the completion-type test required production of answers while the multiple-choice test required recognition of answers.

Completion-Type Test--The items of this test are contained in Quadrilateral Lessons I and II, both expository and discovery modes. These items may be used to determine how well students know each concept immediately after learning.

Multiple-Choice Test--This test is entitled "Tests of Geometry Knowledge: Form JS" and is included as the final component of this paper. The test may be given at some time interval after completion of the lessons in order to determine retention of learning.

REFERENCES

Frayer, D. A. Effects of number of instances and emphasis of relevant attribute values on mastery of geometric concepts by fourth- and sixth-grade children. Wisconsin Research and Development Center for Cognitive Learning, Technical Report No. 116, 1970.

Scott, J. A. The effects on short- and long-term retention and on transfer of two methods of presenting selected geometry concepts. Wisconsin Research and Development Center for Cognitive Learning, Technical Report No. 138, 1970.

Worthen, B. R. Discovery and expository task presentation in elementary mathematics. Journal of Educational Psychology, 1968, 59 (Monogr. Suppl. No. 1, Part 2).

INTRODUCTORY LESSON I

Word List

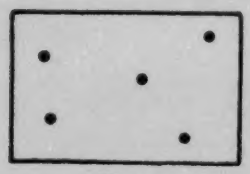
Here is a list of words that are used in this lesson. Some of the words may be new ones for you.

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

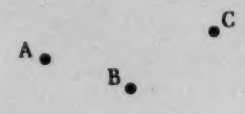
1. location
2. represent
3. point
4. connect
5. curve
6. endpoint
7. segment
8. direction
9. angle
10. acute angle
11. obtuse angle
12. arrowhead
13. ray
14. figure
15. space

1. A point is a location in space. To represent points, we use dots. A dot is not really a point, but it stands for a point.

In the box below, how many points are represented by dots? _____ 5



2. We name a point by placing a capital letter near the dot which represents it.



How many points are pictured? _____ 3

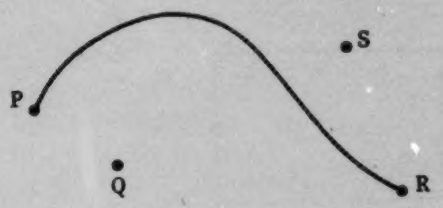
What are the names of the points? _____ A, B, and C

3. A path connecting one point to another point is called a curve.

The curve shown below connects

points _____ and _____.

P and R



4. Curves may be given the name of the points which they connect. For example, the curve shown below may be called FG or GF.

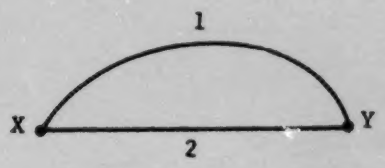
Now look at the curve below.

It may be called _____ or _____.

CD or DC

5. A line segment is the shortest curve that can be drawn between two points. It is straight and does not bend. This might sound strange at first, but this is so. A line segment is straight but it is only a special kind of a curve.

Look at the drawing below. Curve 1 and curve 2 both connect points X and Y.



Which curve is shorter, curve 1 or curve 2?

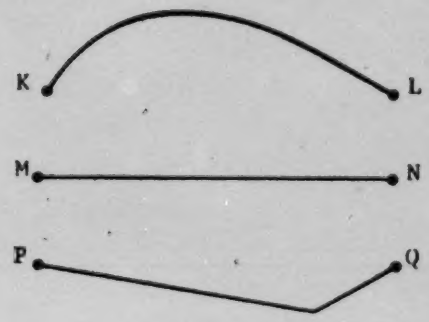
_____

Curve 2, that is, line segment XY. Remember that even though it is straight it can be called a curve.

Are the three figures shown below curves?

_____

Yes



Which of the curves is a line segment? _____

MN (or NM)

6. The line segment shown below ends with points C and D. C and D are called <u>endpoints</u> of line segment CD.

What are the endpoints of the line segment shown below? _____

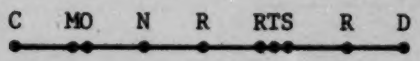
S and T

What are the endpoints of the line segment shown below? _____

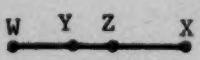
R and S. The endpoints need not be represented by dots. In fact, line segments are usually drawn without dots.

7. Look at the line segment CD shown below. It is made up of the endpoints C and D, and all points on the line segment between C and D. There are more points on the line segment CD than you could count.

Below is an example of just a few of the points on a line segment. There is a letter above each one so that you can name it.



There are many, many points on the line segment shown below, but only points W and X have been named. Mark <u>two</u> other points on the line segment with dots, and name them Y and Z.



or

or any other two points between W and X.

8. A short way of writing "line segment DE" is $\overline{DE}$.

What is a short way of writing "line segment PQ?" _____ $\overline{PQ}$

What is a short way of writing "line segment RS?" _____ $\overline{RS}$

---

9. $\overline{XY}$ is a short way of saying "line segment XY." When you see $\overline{XY}$ you read it by saying "line segment XY."

What would you read when you see $\overline{BC}$?

_____ line segment BC

What would you read when you see $\overline{RT}$?

_____ line segment RT

10. A line segment has endpoints, but a line has no endpoints. A line is a set of points which goes on and on in both directions. Arrowheads on the drawing of a line are used to show that the line goes on and on and on in both directions, forever.

The drawing below shows a picture of line segment RS ($\overline{RS}$).

R _____ S

Does this line segment have endpoints? _____

Yes (Remember you do not need dots to represent the endpoints.)

Does the line segment go all the way to the sides of the page? _____

No

Could you make the line segment longer by using your ruler and making it go on until it reached both sides of the page? _____

Yes

If the page were wider, could you make the line segment even longer? _____

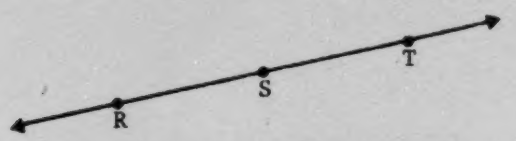
Yes

Is all of the line shown in this drawing? _____

No (The line goes on and on in both directions.)

11. Find the dot named A on the line shown below. This dot represents one point on the line. It is called point A. There are so many points on the line that we cannot mark them all. Only point A is marked.

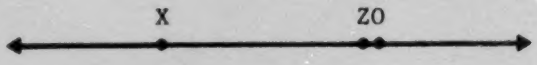
What are the names of the points marked on the line shown below? _____



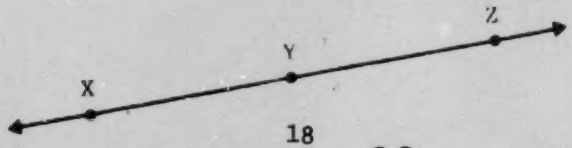
R, S, and T

12. We saw that a line segment was named by the two letters which name its endpoints. A line has no endpoints so we have to name it by picking any two points on the line. For example, the line shown below could be called line EF, line FG, or line EG.

Or, the line shown below could be called ZO or XZ or XO.



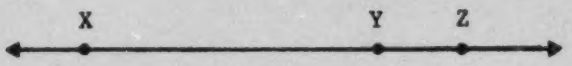
What are three names that could be given to the line drawn below? _____



line XY (or YX)
line YZ (or ZY)
and line XZ (or ZX)

13. Sometimes we are interested in only <u>part</u> of a line.

On the line shown below, find line <u>segment</u> XY ($\overline{XY}$).



Is line segment XY a part of line XZ? _____ Yes

Is line segment YZ a part of line XZ? _____ Yes

Is line segment XZ a part of line XZ? _____ Yes

14. In question 13 you saw that a line segment is part of a line. Now we will look at another part of a line. It is called a ray. It begins at a point and goes on and on in one direction without end.

Look at the drawing of a line below.

Trace with your pencil on the line shown above. Begin at point M and go on and on to the right past point N. The part of the line you traced is called a ray.

Look at the drawing of a ray shown below.

It has one endpoint. The other end has an arrow to show that it really goes on and on. The endpoint of this ray is V. Do not be confused by the arrowhead. Remember that the arrow does not represent a point but instead shows that the ray goes on and on in the direction it shows.

Does the ray have an endpoint? _____ Yes

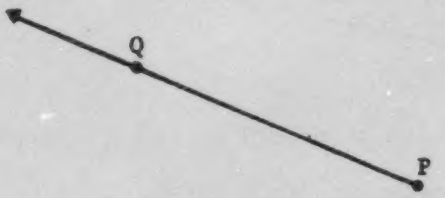
What is the name of the endpoint? _____ V

Does the ray go on and on in one direction without end? _____ Yes

Does the ray go on and on in both directions without end? _____ No

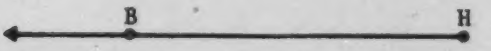
25

15. When we want to give a ray a name, we use two letters. <u>The letter of the endpoint comes first</u>. For example, the endpoint of the ray shown below is P, so we will call the ray PQ.



When you see the name of a ray you know that the <u>first</u> letter is always the endpoint.

Now look at the ray shown below.

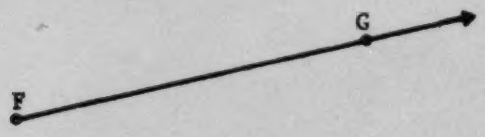


What is the endpoint of this ray? _____ H

What is the name of this ray? (Remember that the <u>first</u> letter is always the endpoint) _____ HB (not BH)

What is the name of the endpoint of a ray named GT? _____ G (not T)

16. We saw that a line goes on and on in two directions and has no endpoints. A ray goes on an on in one direction and has one endpoint. Now look at the figure below.



Does this figure go on and on in both directions or in only one direction? _____

_____

In only one direction

How many endpoints does it have? _____

One

Does the figure represent a line or a ray?

_____

ray

17. Look at the drawing below.

Does the drawing represent a set of points that go on and on in both directions or in only one direction? _____

In both directions

How many endpoints does it have? _____

None

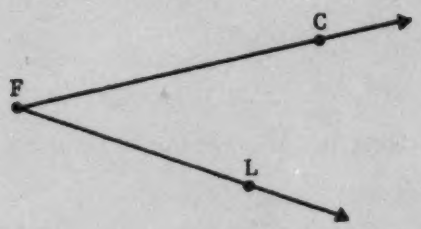
Does the drawing represent a line or a ray?

_____

line

18. Sometimes two rays have the same endpoint. When two rays begin at the same point, they form an angle.

Look at the figure drawn below.



What is the name of the endpoint of ray FC? _____ F

What is the name of the endpoint of ray FL? _____ F

Do rays FC and FL have the same endpoint? _____ Yes (F)

Now look at the next figure.

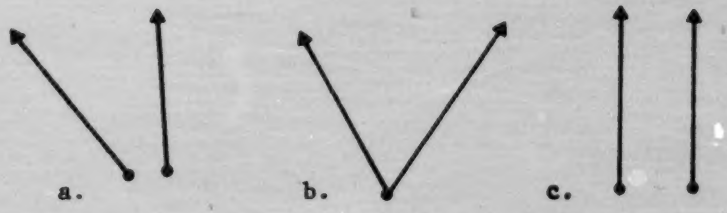
How many rays are pictured? _____ 2

Do the rays have the same endpoint? _____ Yes

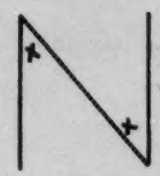
19. In the drawings below, angles formed by rays beginning at the same point are marked with an X.

On the drawings below, put an X by each angle.

Which of the following figures shows an angle? _____

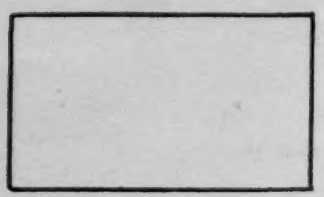


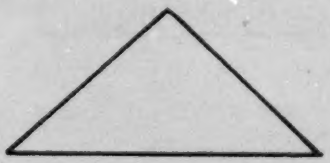
20. Sometimes in pictures of angles, we use line segments instead of rays. For example, the letter N is made up of line segments which form two angles. Both of these angles are marked with an X on the large letter N shown below.

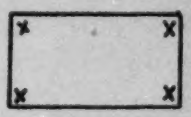


Put an X in the three angles formed by the letter M shown below.

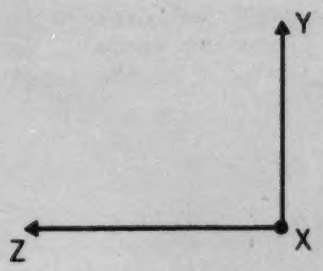
Put an X in each angle formed by the line segments in the following figures.





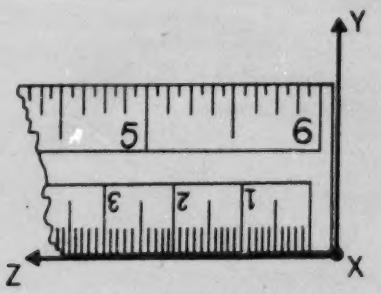


21. Look at the angle made by rays XY and XZ in the figure below.



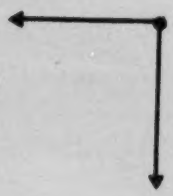
This is a picture of a special kind of angle called a <u>right angle</u>. This kind of angle may also be called a "square corner."

In some of the lessons which you will be doing you will be asked if an angle is a right angle. You can check to find out whether or not an angle is a right angle by placing your ruler in the corner like this:



Put the corner of the ruler at X and let the bottom of the ruler lie along the bottom ray XZ. Be sure that the corner of the ruler is touching the corner at X. Then look at ray XY. If ray XY lies along the end of the ruler, as is shown here, then you can say that this is a right angle.

22. Now look at the angles drawn below. Use your ruler to find out which one is a right angle. Which angle is a right angle? _____



a.

b.

a

23. Now look at the drawings below. Which one looks like a right angle? _____

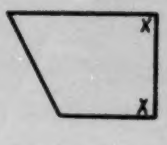
a.

b.

Use your ruler to check your answer.

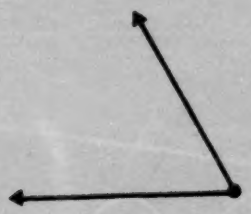
b

24. Use your ruler to find the right angles in the figure below. Put an X in the right angles.



25. Look at this angle. It is <u>not</u> a right angle.

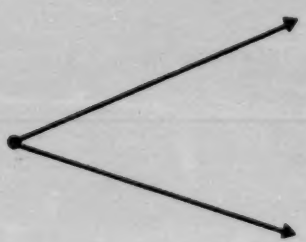
Use your ruler to be sure.



You will notice that this angle is "smaller" than a right angle. If you wish to think of it this way you might say that the space between the rays is smaller. This is called an <u>acute</u> angle.

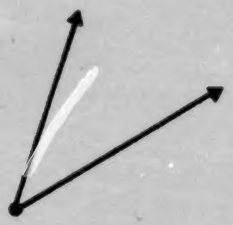
You might also think of it in terms of the hands on the clock. At a quarter till twelve or a quarter past twelve the hands would make a right angle. At less than a quarter till or a quarter past twelve, for example ten till or five after, the hands make acute angles.

This is another acute angle.



Use your ruler to be sure of this.

26. Look at this figure.

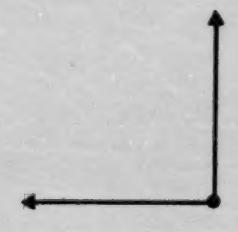


Is it a right angle? _____ No

Is it an acute angle? _____ Yes

Use your ruler.

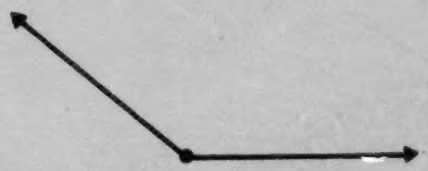
27. Look at this figure.



Is it a right angle? _____ Yes

Is it an acute angle? _____ No

28. Now look at this angle. It is not a right angle and it is not an acute angle either. Use your ruler to check.



It is "bigger" than a right angle, or if you care to think of it this way, the space between the rays in this angle is greater than the space between the rays of a right angle. This is called an obtuse angle.

Use your ruler and check the angle. Is it "bigger" than a right angle? _____ Yes

If you wish to think of the clock again, you might say that when it is more than a quarter before or after twelve, for example at twenty till or twenty-five after, the hands make an obtuse angle.

Now look at the two words carefully. Do not confuse them as you will need to be able to tell acute and obtuse and right angles apart many times in the lessons which follow.

ACUTE. Repeat it to yourself a few times, then think of an acute angle or find an example. Now write the word here _ _ _ _ _.

OBTUSE. Repeat this to yourself a few times and think of an obtuse angle or find an example. Now write the word here _ _ _ _ _ _.

Compare the words and remember how they are different.

29. Now look at this angle.

Is this a right angle? _____ No

Is this an acute angle? _____ No

Is this an obtuse angle? _____ Yes

Use your ruler to check.

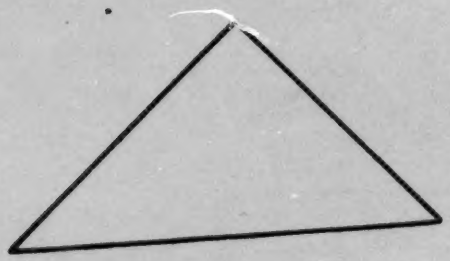
Remember the difference between acute and obtuse angles.

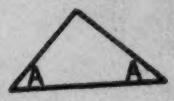
Write the difference here _____

_____

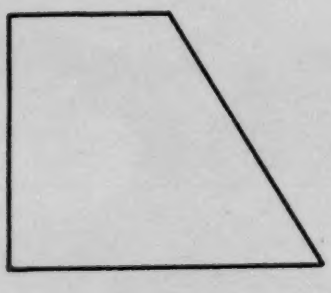
An acute angle is smaller than a right angle. An obtuse angle is bigger than a right angle.

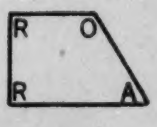
30. In the figure below, use your ruler to find the acute angle or angles. Put an A in each acute angle.





31. In the figure below, use your ruler to test the angles. Put an R in each right angle, an O in each obtuse angle, and an A in each acute angle.





INTRODUCTORY LESSON II

Word List

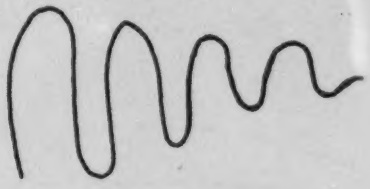
Here is a list of words that are used in this lesson. Some of the words may be new ones for you.

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

1. description
2. simple
3. non-simple
4. imagine
5. surface
6. geometric
7. polygon
8. common
9. intersect
10. parallel
11. distance
12. opposite
13. length

1. A curve which has endpoints is called an open curve.

Using your pencil, trace the drawing shown below.

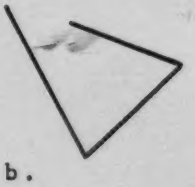


Did you come back to where you started? _____ No

Does the drawing have endpoints? _____ Yes
Remember that endpoints need not have dots.

Which of the drawings below shows an open curve; that is, which one does not come back to where it started? _____ b

a.



b.

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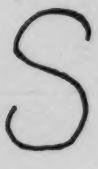
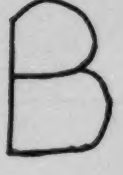
2. Which of these drawings is an open curve? _____ a

a. 

b. 

3. A figure that is drawn by returning to the starting place has no endpoints and is called a closed curve. Trace the next drawing with your pencil.

Did you come back to where you started? _____ Yes

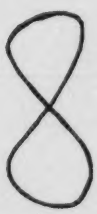
Does the drawing have endpoints? _____ No

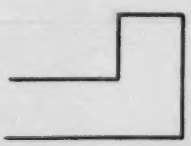
Which of the following figures has no endpoints and so could be called a closed curve? _____ a

a.

b.

4. Which of these figures is a closed curve? _____ a

a. 

b. 

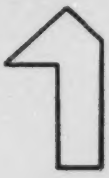
5. A closed curve which can be drawn without crossing itself at any point is called a simple closed curve. Look at the drawing below.

Does the drawing cross itself when you draw it? _____ No

Is it a simple closed curve? _____ Yes

---

6. Now look at the next drawings.

a. 

b.

Which is a simple closed curve? _____ a

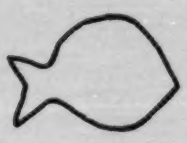
Which of the figures below is a simple closed curve? _____ a

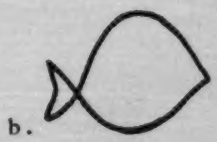
a.

b.

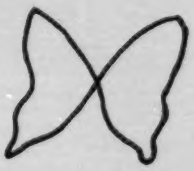
7. The drawing shown below crosses itself at one point. It is <u>not</u> a simple closed curve. We will call this kind of curve a <u>non-simple</u> closed curve.

Which of the drawings below is a non-simple closed curve? _____ b





Which of the drawings below is a non-simple closed curve? _____ a

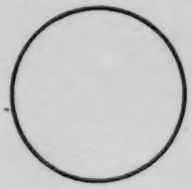


8. Think of the top of a table. Now imagine that the table is beginning to grow longer and longer, and wider and wider, getting bigger without end. A flat surface like this that goes in all directions without end is called a plane. The top of your desk is flat and is something like a plane. Is your desk like a whole plane or only part of a plane? _____

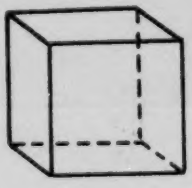
Only part

(Because the desk has edges and doesn't go in all directions without end.)

9. Figures which are made up of points all in the same plane are called plane figures. Look at the figure drawn below. All of its points are in one plane, so it is called a plane figure.



Now look at the next picture. It is a picture of a block. Some of the points which make up the block are in different planes. Since its points are not in one plane, the block is not a plane figure. We call figures like this that have points in different planes solid figures. The dotted lines show the parts of the figure that we can't see.



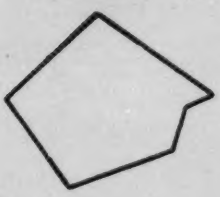
9. (continued)

Which of the following figures represents a <u>plane</u> figure? _____ b

a.

b.

Which of the following figures represents a <u>plane</u> figure? _____ a

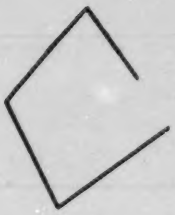


a.

b.

Which of the following drawings represents a <u>solid</u> figure? _____ a

a.

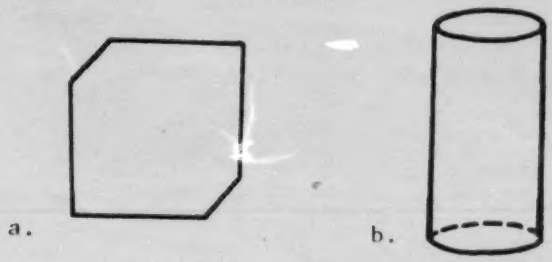


b.

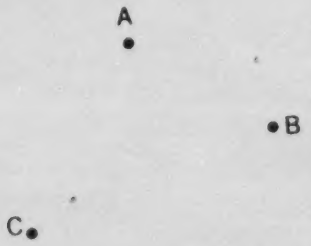
9. (continued)

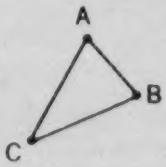
Which of the following drawings represents a <u>solid</u> figure? _____

b



10. Connect the points below with line segments $\overline{AB}$, $\overline{BC}$ and $\overline{CA}$.





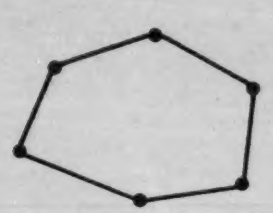
Is your figure a simple closed curve? _____

Yes

Is your figure a plane figure? _____

Yes

11. We give a special name to a plane simple closed curve which is made by joining line segments. We call it a polygon. Look at the figure below.

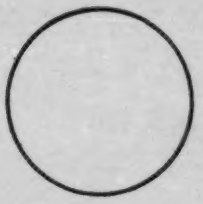


Is it a simple closed curve? _____	Yes
Is it a drawing of a plane figure? _____	Yes
Is it made of line segments? _____	Yes
Is it a polygon? _____	Yes

12. Now look at this figure.

Is it a drawing of a plane figure? _____	Yes (To be a plane figure, figure need not be a closed figure.)
Is it made up of line segments? _____	Yes
Is it a simple closed curve? _____	No
Is it a polygon? _____	No

13. Now look at the drawing below.



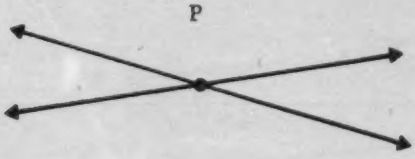
Is it a drawing of a plane figure? _____ Yes

Is it a simple closed curve? _____ Yes

Is it made up of line segments? _____ No

Is it a polygon? _____ No

14. Two lines are drawn below. These two lines go through the same point P. We call P a common point of the lines. When two lines have a common point, we say the lines intersect.



Now look at the next figure.

Do the lines have a common point? _____ Yes

Do the lines intersect? _____ Yes

14. (continued)

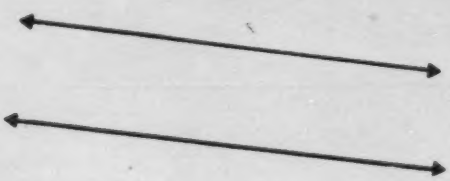
Remember that the picture of a line shows only part of a line. Do the lines shown below intersect even though the picture doesn't show a common point? (Remember that both lines go on and on.)

_____

Yes

15. When two lines in the same plane do not intersect, we say that the lines are parallel.

Look at the following figure.

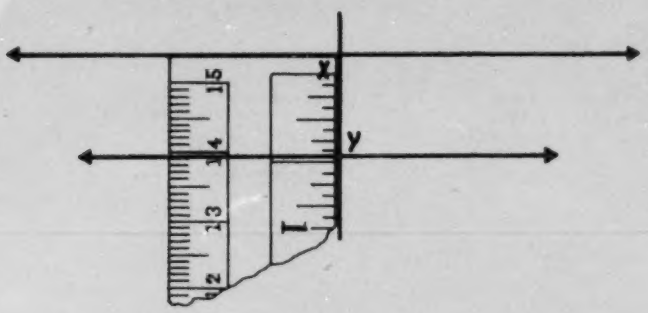


Do the lines intersect? _____ No

Are the lines parallel? _____ Yes

15. (continued)

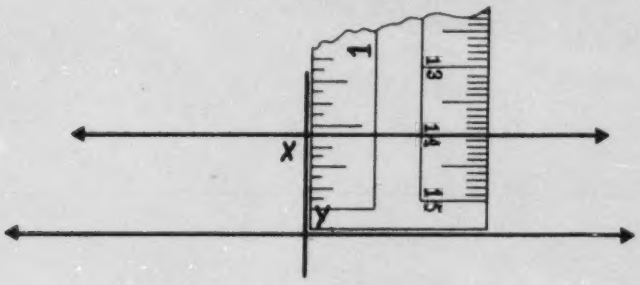
There is one easy test you can use to find out whether or not two lines are parallel. Use your ruler as follows:



Place the end of your ruler flat against the top line and draw a line along one side like this.

The angle marked X is a right angle, as we have seen.

Now turn the ruler around and check like this:



If the angle marked Y is also a right angle then you can say that the lines are parallel.

So in the rest of these lessons whenever you are asked if lines are parallel, or when you are asked if you notice something about a pair of lines, draw a line and make the test as you have been shown above. Be sure to draw the line whenever you want to make this test.

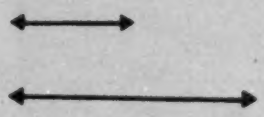
15. (continued)

Which of the pairs of lines below is

parallel? _____ b

Use your ruler to check your answer.

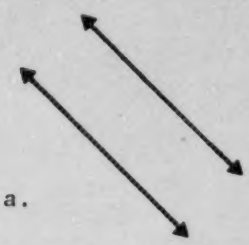
a.

b. 

Which of the following pairs of lines is

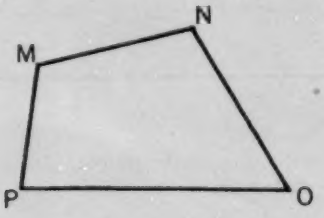
parallel? (Remember to draw the line and use your ruler.)

_____ a

a. 

b.

16. Now look at the next drawing.



Is $\overline{MN}$ parallel to $\overline{PO}$? _____ No

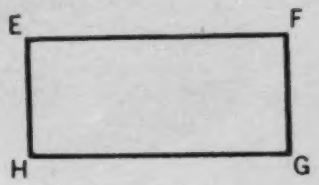
Is $\overline{MP}$ parallel to $\overline{NO}$? _____ No

Remember to use your ruler.

How many pairs of parallel sides does this

figure have? _____ 0 pairs

17. Look at this figure.



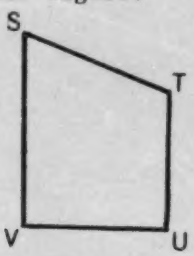
Is $\overline{EF}$ parallel to $\overline{HG}$? _____ Yes

Is $\overline{EH}$ parallel to $\overline{FG}$? _____ Yes

How many pairs of parallel sides does this figure have? _____ 2 pairs

Use your ruler to check your answer.

18. Now look at this figure.



Is $\overline{ST}$ parallel to $\overline{VU}$? _____ No

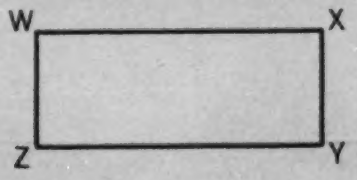
Is $\overline{SV}$ parallel to $\overline{TU}$? _____ Yes

How many pairs of parallel sides does this figure have?

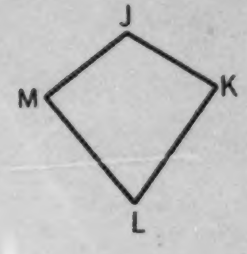
_____ 1 pair

Use your ruler to check your answer. ($\overline{SV}$ is parallel to $\overline{TU}$)

19. Look at the polygon shown below. $\overline{WX}$ and $\overline{ZY}$ are <u>opposite</u> sides. $\overline{WZ}$ and $\overline{XY}$ are opposite sides.



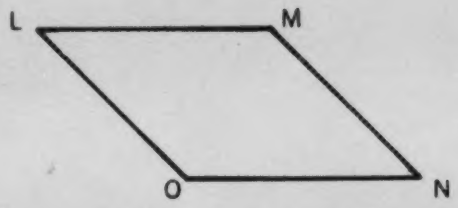
Now look at the next figure.



What side is opposite from side $\overline{JK}$? _____ $\overline{ML}$ (or $\overline{LM}$)

What side is opposite from side $\overline{KL}$? _____ $\overline{JM}$ (or $\overline{MJ}$)

20. Look at the next figure.



Are $\overline{LM}$ and $\overline{MN}$ opposite sides?

_____

No

Are $\overline{LM}$ and $\overline{ON}$ opposite sides?

_____

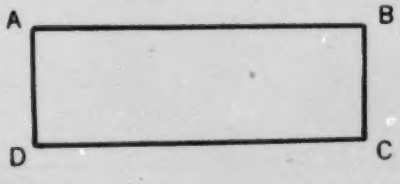
Yes

Are $\overline{LO}$ and $\overline{MN}$ opposite sides?

_____

Yes

21. Now look at the next figure.



Does $\overline{AB}$ seem to be the same length as $\overline{DC}$? _____

Yes

Does $\overline{AB}$ seem to be the same length as $\overline{AD}$? _____

No

TRIANGLE LESSON: EXPOSITORY MODE

Word List

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

1. triangle
2. polygon
3. right angle triangle
4. acute angle triangle
5. obtuse angle triangle
6. equilateral triangle
7. isosceles triangle

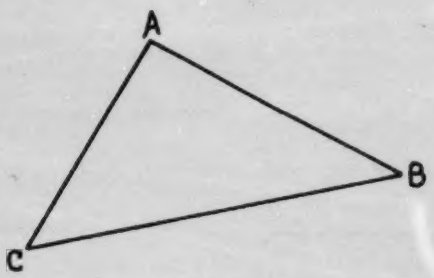
Hello,

You are now ready to start your third lesson. This lesson is not quite like the last two lessons. You have been told about the difference in the form of these lessons. Now we want to point out some things to keep in mind as you go through this and the following lessons.

You may have noticed that the last two lessons were about lines and parts of lines (that is, line segments and rays) and about angles. You learned how to tell whether or not two lines are parallel. And you learned how to tell a right angle, an acute angle, and an obtuse angle apart. As you study the figures in this and the following lessons you will use what you learned.

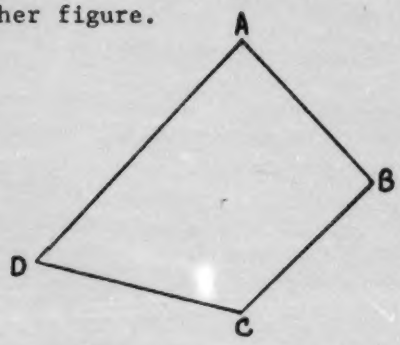
To learn about the figures in the next lesson you will only have to learn about the line segments (or sides, as we will call them) and the angles. When you are learning about a figure look at the sides, find out if they are the same length, and find out whether they are parallel. Look at each angle and check whether it is a right angle or an acute angle or an obtuse angle. You do not have to think of anything else like whether it is big or small, or thin or fat, or straight or turned around. Just think about the sides and the angles and you will learn about the figures.

1. A special kind of polygon made up of three line segments is called a triangle. The following six figures will help you learn how to tell whether or not a figure is a triangle. Look at them carefully and notice how they are alike and how they are different. The polygon drawn below is a <u>triangle</u>.



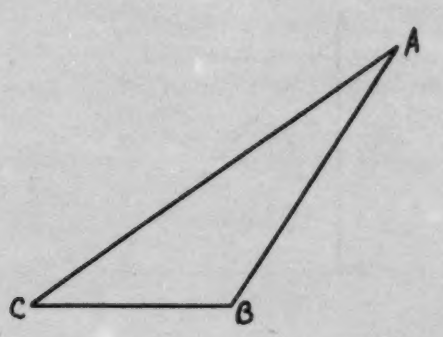
It has three sides.

2. Here is another figure.



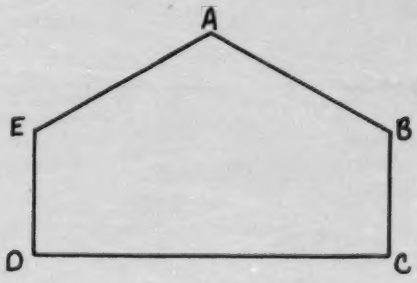
This <u>is not</u> a triangle. It is made up of more than three sides.

3. Look at the next drawing. This <u>is</u> a triangle.



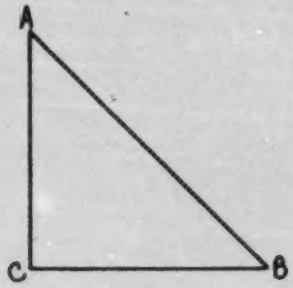
It has three sides.

4. Now look at this figure.



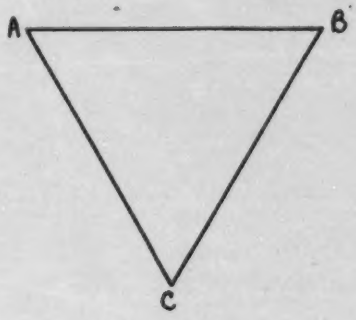
This <u>is not</u> a triangle. It has more than three sides.

5. This drawing <u>is</u> a triangle. Count the line segments.



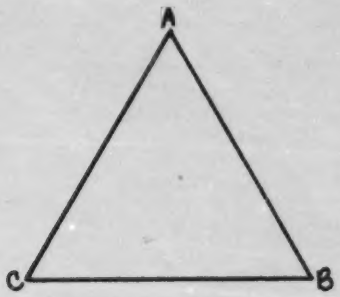
It has three sides.

6. And this drawing <u>is</u> a triangle because it has three sides.



To find out whether or not a polygon is a triangle you have to do only one thing; and that is to make sure that the figures have three and only three sides.
Check each example.

7. In the rest of this lesson you will be studying about special kinds of triangles. One special kind of triangle is called an equilateral triangle. In an equilateral triangle the three sides are equal in length. The next four figures will help you to learn how to tell whether or not a triangle is equilateral. Look carefully at the figures and notice how they are alike and how they are different. The figure below is an equilateral triangle.



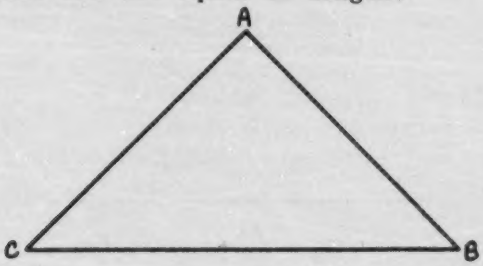
Side AB is 1-5/8 inches long.

Side AC is 1-5/8 inches long.

Side CB is 1-5/8 inches long.

Check these measures with your ruler. Notice that the three sides are equal in length.

8. Now look at this figure. It <u>is not</u> an equilateral triangle. The three sides are not equal in length.



Check the measures of the sides.

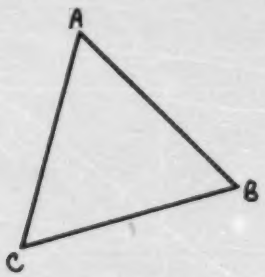
Side AB is 1-3/4 inches long.

Side AC is 1-3/4 inches long.

Side CB is 2-1/2 inches long.

$\overline{AC} = \overline{AB}$ but $\overline{CB} \neq \overline{AB}$ ($\neq$ means "not equal to")

9. Now look at this drawing. It <u>is</u> an equilateral triangle.



Check the measures of the sides and you will see:

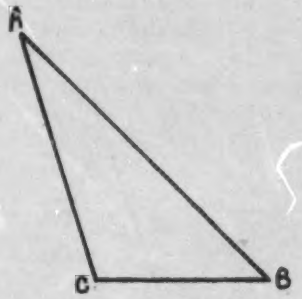
$\overline{AB}$ is 1-1/4 inches long.

$\overline{AC}$ is 1-1/4 inches long,

$\overline{CB}$ is 1-1/4 inches long.

The sides are of equal length.

10. The next figure <u>is not</u> an equilateral triangle.



Check the measures of the sides.

$\overline{AB}$ is 2 inches long.

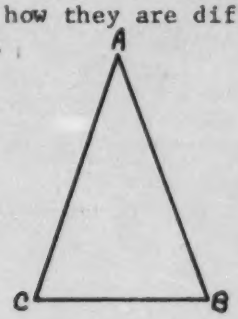
$\overline{AC}$ is 1-1/2 inches long.

$\overline{CB}$ is 1 inch long.

The sides are not equal in length.

There is only one thing you must know if you want to know whether or not a triangle is equilateral. You must find out if the three sides are equal in length. Check each of the examples.

11. Another kind of triangle is an isosceles triangle. It has two sides which are equal in length. The following six figures will help you learn whether or not a figure is an isosceles triangle. Look at them carefully and notice how they are alike and how they are different. This is an isosceles triangle.



Check the measures of the sides.

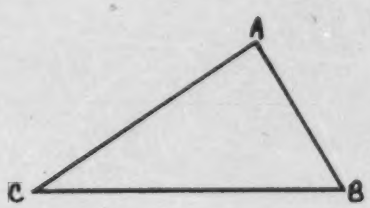
$\overline{AB}$ is 1-1/2 inches long.

$\overline{AC}$ is 1-1/2 inches long.

$\overline{CB}$ is 1 inch long.

Two of the sides are equal in length.

12. Look at the drawing below. It is not an isosceles triangle. It does not have two sides equal in length.



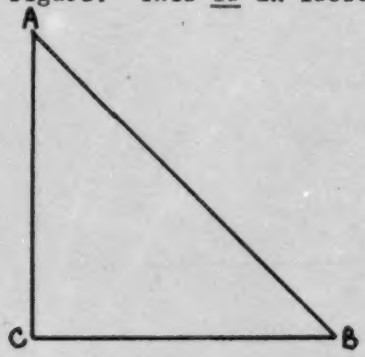
Check the measures of the sides.

$\overline{AB}$ is 1 inch long.

$\overline{AC}$ is 1-1/2 inches long.

$\overline{CB}$ is 1-3/4 inches long.

13. Here is another figure. This <u>is</u> an isosceles triangle.



Check the measures of the sides.

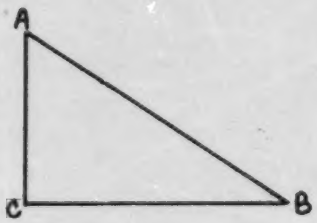
$\overline{AB}$ is 2-1/2 inches long.

$\overline{AC}$ is 1-3/4 inches long.

$\overline{CB}$ is 1-3/4 inches long.

Two of the sides are equal in length.

14. Here is another figure. This <u>is not</u> an isosceles triangle. No two sides are equal in length.



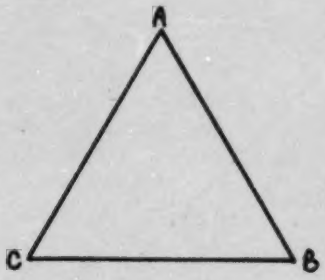
Check the measures of the sides.

$\overline{AB}$ is 1-3/4 inches long.

$\overline{AC}$ is 1 inch long.

$\overline{CB}$ is 1-1/2 inches long.

15. The drawing below <u>is</u> an isosceles triangle.



Check the measures of the sides.

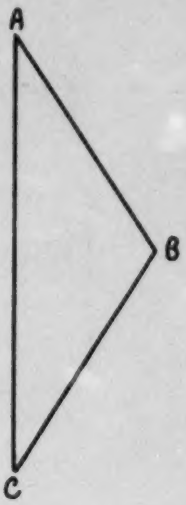
$\overline{AB}$ is 1-1/2 inches long.

$\overline{AC}$ is 1-1/2 inches long.

$\overline{CB}$ is 1-1/2 inches long.

At least two of the sides are equal in length.

16. And this is an isosceles triangle.



Check the measures of the sides.

$\overline{AB}$ is 1-1/2 inches long.

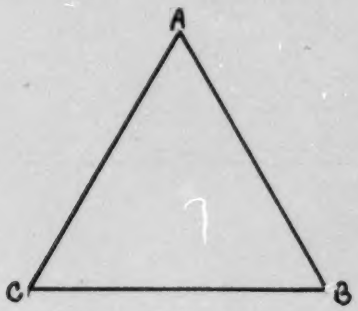
$\overline{AC}$ is 2-1/2 inches long.

$\overline{BC}$ is 1-1/2 inches long.

Two of the lines are equal in length.

To find out whether or not a triangle is an isosceles triangle there is one thing you must find out, and that is whether or not at least two of the lines are equal in length. Check the examples.

17. Another special kind of triangle is called an <u>acute angle triangle</u>. This figure is an acute angle triangle. In acute angle triangles all angles are acute. The next six figures will help you learn how to tell whether or not a figure is an acute angle triangle. Look at them carefully and note how they are alike and how they are different. This <u>is</u> an acute angle triangle.

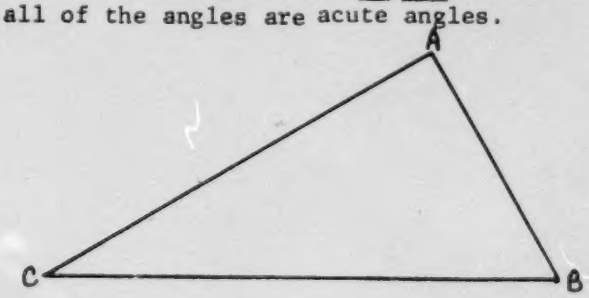


Check the angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is acute.

All the angles are acute.

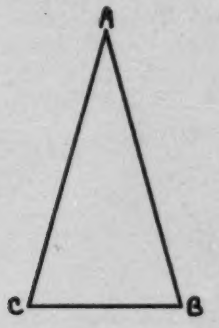
18. Now look at this figure. It <u>is not</u> an acute angle triangle. Not all of the angles are acute angles.



Check the angles.

The angle at A is a right angle.
The angle at B is an acute angle.
The angle at C is an acute angle.

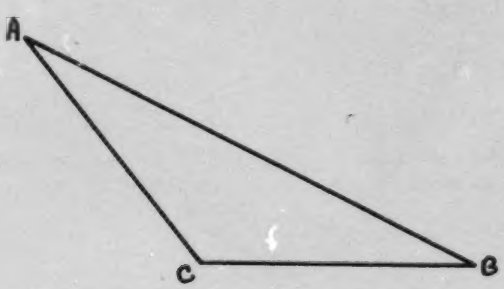
19. The next figure <u>is</u> an acute angle triangle. Look at it carefully and you will see that each angle is an acute angle.



Check the angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is acute.

20. Here is another figure.



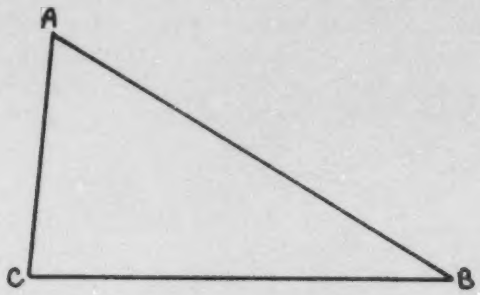
This <u>is</u> <u>not</u> an acute angle triangle.

Check the angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is obtuse.

Not <u>all</u> of the angles are acute angles. One is obtuse. Therefore, the triangle is not an acute angle triangle.

21. Now look at this figure. This <u>is</u> an acute angle triangle.



Check the angles.

The angle at A is acute.
The angle at B is acute
The angle at C is acute.

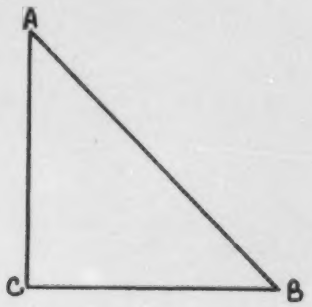
22. And this triangle <u>is</u> an acute angle triangle.

Check the angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is acute.

When you know by looking at the figure and counting the line segments that a figure is a triangle, there is only one other thing you have to find out to tell whether or not it is an acute angle triangle. You must find out whether or not all angles are acute angles.

23. Still another special kind of triangle is called a right angle triangle. A right angle triangle is a triangle that has one right angle. The next six figures will help you learn how to tell whether or not a triangle is a right angle triangle. Look at them carefully and notice how they are alike and how they are different. This figure is a right angle triangle.

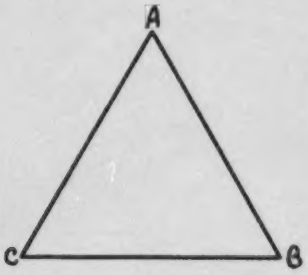


Look at it. Use your ruler as you learned in the first lesson to help you check the three angles in this figure.

The angle at A is an acute angle.
The angle at B is an acute angle.
The angle at C is a right angle.

Notice that the angle at C is a right angle and the angles at A and B are acute.

24. Now look at this figure. It <u>is not</u> a right angle triangle because it has no right angle.

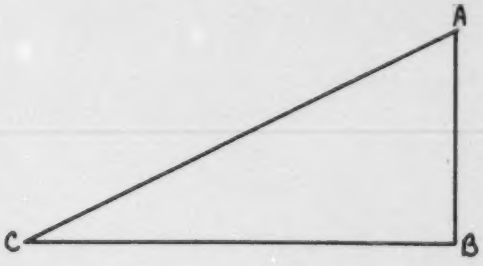


Look at it. Use your ruler to help you check the three angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is acute.

None of the angles is a right angle so it is not a right angle triangle.

25. Here is another figure. One of the angles is a right angle.

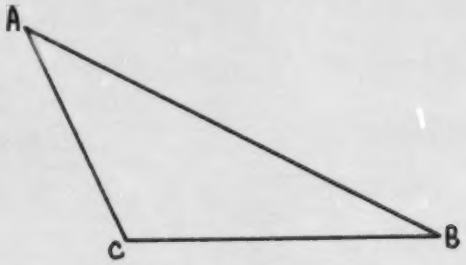


This <u>is</u> a right angle triangle. Use your ruler to check the angles.

The angle at A is an acute angle.
The angle at B is a right angle.
The angle at C is an acute angle.

Note that the angle at B is a right angle.

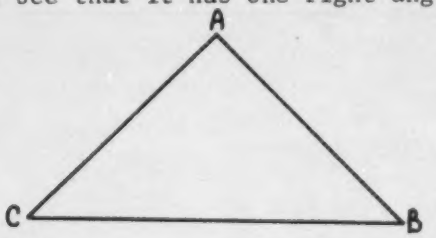
26. Look at this figure. No angle is a right angle.



This <u>is not</u> a right angle triangle.

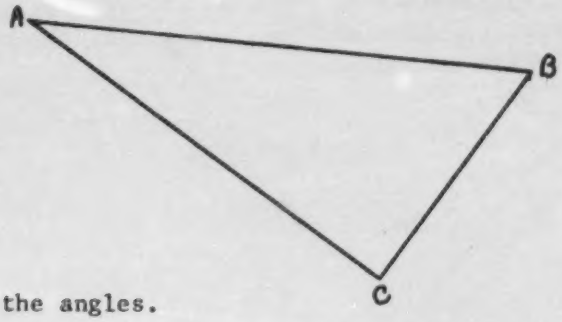
The angle at A is acute.
The angle at B is acute.
The angle at C is obtuse.

27. This figure <u>is</u> a right angle triangle. Check the angles and you will see that it has one right angle.



The angle at A is a right angle.
The angle at B is an acute angle.
The angle at C is an acute angle.

28. And this figure is a right angle triangle. When you check the angles you should expect to find one right angle.

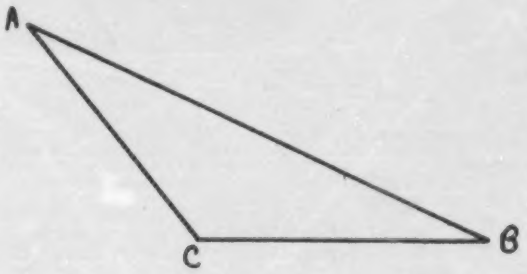


Check the angles.

The angle at A is an acute angle.
The angle at B is an acute angle.
The angle at C is a right angle.

When you know that a figure is a triangle, there is only one thing you must find out in order to know whether or not it is a right angle triangle: you must find out if one of the angles is a right angle.

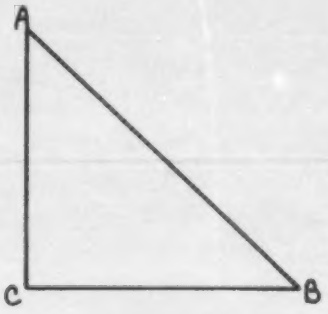
29. The last kind of triangle we will study is called an obtuse angle triangle. One of the angles of an obtuse angle triangle is always obtuse. The following six figures will help you learn how to tell whether or not a triangle is an obtuse angle triangle. Look at them carefully and notice how they are alike and how they are different. This is an obtuse angle triangle.



Use your ruler to check the angles. One is obtuse.

The angle at A is acute.
The angle at B is acute.
The angle at C is obtuse.

30. Look at this figure. It does not have an obtuse angle.

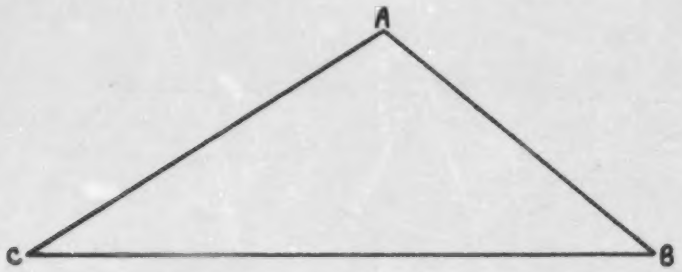


This is not an obtuse angle triangle.

Check the angles.

The angle at A is an acute angle.
The angle at B is an acute angle.
The angle at C is a right angle.

31. Now look at this drawing.



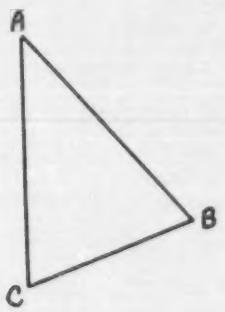
This <u>is</u> an obtuse angle triangle.

Check the angles.

The angle at A is obtuse.
The angle at B is acute.
The angle at C is acute.

One of the angles is an obtuse angle.

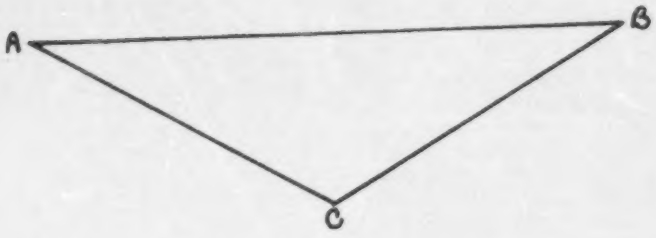
32. Here is another drawing. It does not have an obtuse angle and so it <u>is not</u> an obtuse angle triangle.



Check the angles.

The angle at A is acute.
The angle at B is acute.
The angle at C is acute.

33. This figure <u>is</u> an obtuse angle triangle.



Check the angles and you will see that one is an obtuse angle.

The angle at A is acute.
The angle at B is acute.
The angle at C is obtuse.

34. And this <u>is</u> an obtuse angle triangle.

Check the angles and notice that one is an obtuse angle.

The angle at A is acute.
The angle at B is obtuse.
The angle at C is acute.

When you know that a figure is a triangle there is one other thing you must find out in order to tell whether or not it is an obtuse angle triangle: You must find out whether or not one of the angles is obtuse.

QUADRILATERAL LESSON I: EXPOSITORY MODE

77

Word List

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

1. quadrilateral
2. trapezoid
3. parallelogram
4. rhombus

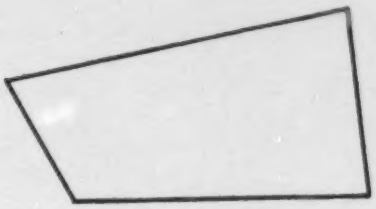
Hello,

This lesson is not quite like the last lessons. You have been told about the difference in the form of these lessons. Now we want to point out some things to keep in mind as you go through this and the following lessons.

You may have noticed that the last two lessons were about lines and parts of lines (that is, line segments and rays). You learned how to tell whether or not two lines are parallel. As you study the figures in this and the following lessons, you will use what you learned.

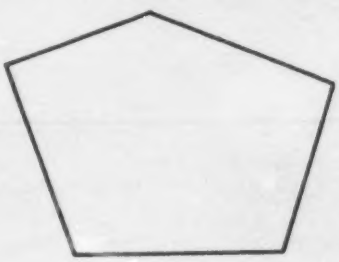
To learn about the figures in the next lesson you will only have to learn about the line segments, or sides as we will call them. When you are learning about a figure, look at the sides. Find out if they are the same length or not and whether they are parallel or not. You do not have to think of anything else about the figure, such as whether it is big or small, or thin or fat, or straight or turned around. Just think about the sides. That is how you will learn about the figure.

1. All polygons which are made up of four line segments are called quadrilaterals. The polygon drawn below is a quadrilateral.



Look at it. It has four sides.

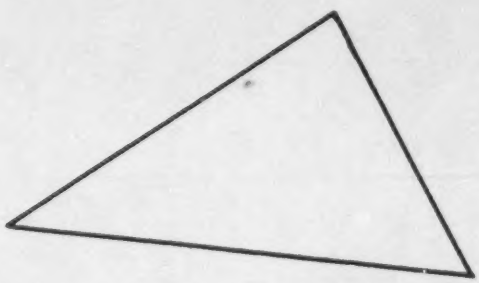
2. Here is another figure. It is not made from four sides.



This is not a quadrilateral. It does not have only four sides. It has five sides.

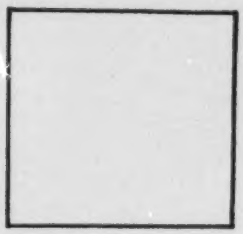
3. Look at the next drawing. It has four sides, so it <u>is</u> a quadrilateral.

4. Look at the next drawing. It does not have four sides.



This <u>is</u> <u>not</u> a quadrilateral. It has only three sides.

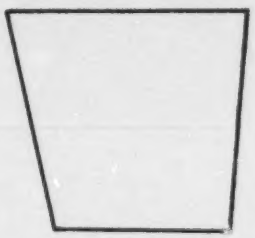
5. This drawing <u>is</u> a quadrilateral.



It has four and only four sides.

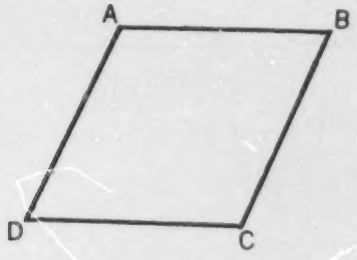
You know without counting that if it is a quadrilateral it can only have four sides.

6. And this drawing <u>is</u> a quadrilateral. It also has just four sides.



To find out whether or not a polygon is a quadrilateral, you have to do only one thing. You have to count the number of sides and make sure that there are four, and only four.

7. One special kind of quadrilateral is a rhombus. Any figure which has all sides of equal length is called a rhombus. The following six figures will help you tell whether or not a figure is a rhombus. Look at them carefully and notice how they are alike and how they are different. This figure is a rhombus.



The measures of the lengths of the sides are written below. Check them with your ruler.

$\overline{AB}$ is 1-1/4 inches long.

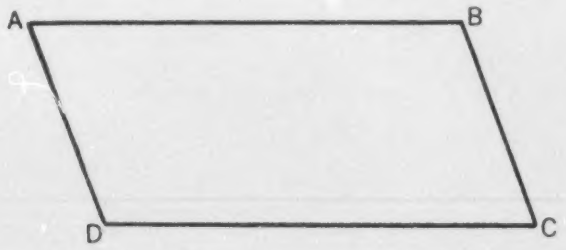
$\overline{AD}$ is 1-1/4 inches long.

$\overline{BC}$ is 1-1/4 inches long.

$\overline{DC}$ is 1-1/4 inches long.

Notice that $\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$

8. Now look at the drawing below. It <u>is</u> <u>not</u> a rhombus.



The measures of the length of the sides are written below.

$\overline{AB}$ is 2-1/2 inches long.

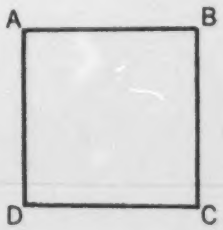
$\overline{DC}$ is 2-1/2 inches long.

$\overline{AD}$ is 1-1/4 inches long.

$\overline{BC}$ is 1-1/4 inches long.

The four sides are not equal in length and so it is not a rhombus.

9. Here is another figure. This <u>is</u> a rhombus.



Here are the lengths of the sides.

$\overline{AB}$ is 1 inch long.

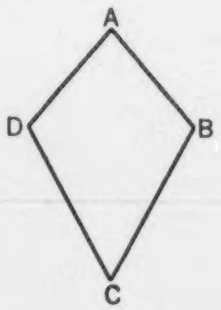
$\overline{AD}$ is 1 inch long.

$\overline{BC}$ is 1 inch long.

$\overline{DC}$ is 1 inch long.

All the sides in this figure are of equal length.

10. Now look at this figure. It <u>is</u> <u>not</u> a rhombus because all sides are not of equal length.



The measures of the sides are written below.

$\overline{AB}$ is 3/4 inch long.

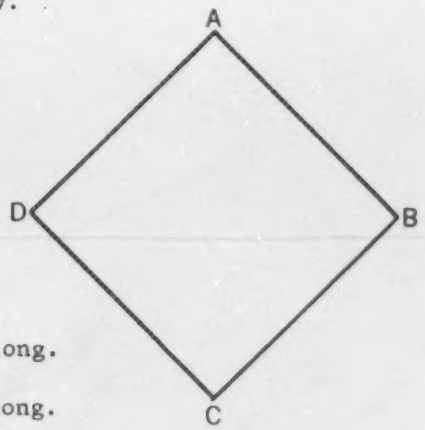
$\overline{AD}$ is 3/4 inch long.

$\overline{BC}$ is 1 inch long.

$\overline{DC}$ is 1 inch long.

All the sides in this figure are not of equal length. Check with your ruler if you wish.

11. This figure <u>is</u> a rhombus. The sides are equal in length. Notice the measures below.



$\overline{AB}$ is 1-1/2 inches long.

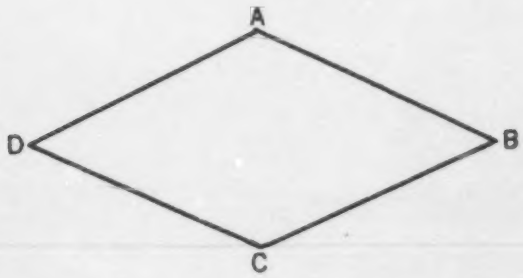
$\overline{AD}$ is 1-1/2 inches long.

$\overline{BC}$ is 1-1/2 inches long.

$\overline{DC}$ is 1-1/2 inches long.

$\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$

12. And this figure <u>is</u> a rhombus.



Here are the measures of the sides.

$\overline{AB}$ is 1-1/2 inches long.

$\overline{AD}$ is 1-1/2 inches long.

$\overline{BC}$ is 1-1/2 inches long.

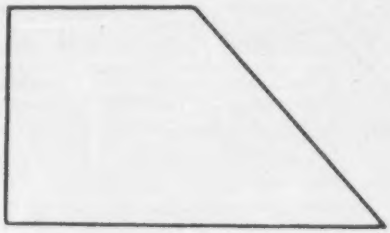
$\overline{DC}$ is 1-1/2 inches long.

$\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$.

So now you know that when a figure is a quadrilateral there is only one other thing you have to find out to tell whether or not it is a rhombus. You need only find out whether or not all sides are equal in length. Check the examples.

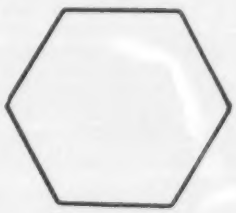
13. The first six figures you studied (questions 1 to 6) were to help you learn how to tell whether or not a figure was a quadrilateral. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a quadrilateral. First we must be sure that you can remember the word quadrilateral itself. Repeat it several times to yourself: quadrilateral, quadrilateral, quadrilateral. Now write the word quadrilateral here. _____ Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

14. Here is the first figure.



Look at it. It has four sides.

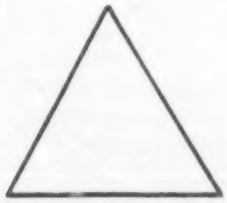
15. Here is another figure.



This is not a quadrilateral. It does not have only four sides. It has six sides.

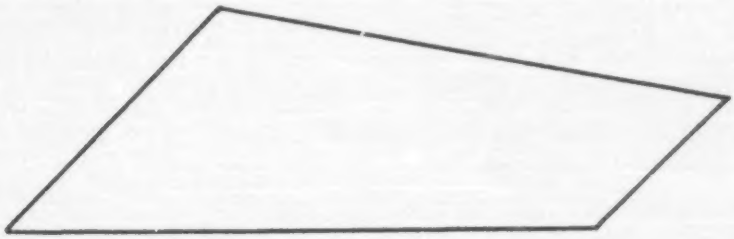
16. Look at the next figure. It has four sides, so it is a quadrilateral.

17. Look at this drawing. It does not have four sides.



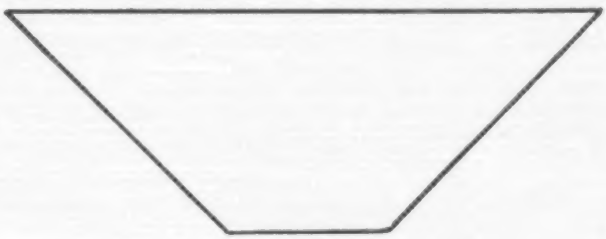
This <u>is</u> <u>not</u> a quadrilateral. It has only three sides.

18. This drawing <u>is</u> a quadrilateral.



It has four and only four sides.

19. And this drawing is a quadrilateral. It also has just four sides.



To find out whether or not a polygon is a quadrilateral, you have to do only one thing. You have to count the number of sides and make sure that there are four, and only four.

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20. Using a ruler, connect as many points as you need to close the figure so that it <u>is</u> <u>not</u> a quadrilateral.

21. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a quadrilateral.

22. How many sides do quadrilaterals have? ____

23. Using a ruler, connect as many points as needed to close the figure so it has only 4 sides.

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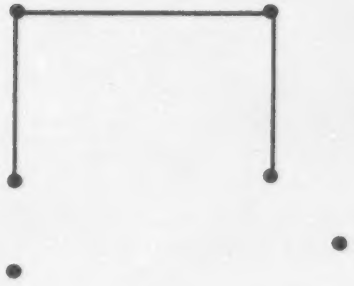
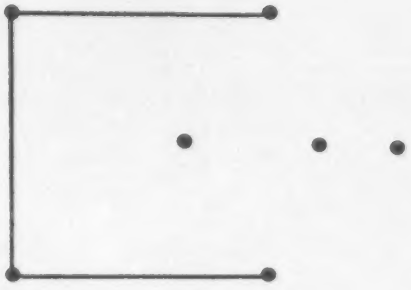
24. List all that is needed to completely describe quadrilateral.

25. Using a ruler, complete this figure so that it is not a quadrilateral.



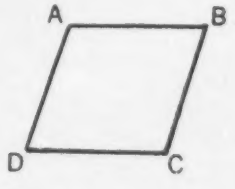
26. Using a ruler, complete this figure so that it is a quadrilateral.



27. In questions 7 to 12 there were six figures which you studied to help you learn to tell whether or not a figure is a rhombus. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a rhombus. First we must be sure you can remember the word itself. Repeat it several times to yourself: rhombus, rhombus, rhombus. Now write the word rhombus here. _____

Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

28. Here is the first figure.



The measures of the lengths of the sides are written below. Check them with your ruler.

$\overline{AB}$ is 3/4 inch long

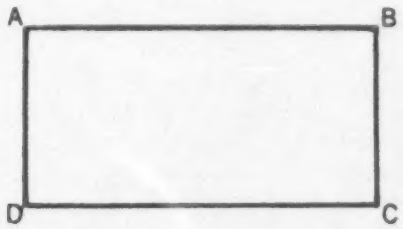
$\overline{AD}$ is 3/4 inch long

$\overline{BC}$ is 3/4 inch long

$\overline{DC}$ is 3/4 inch long

Notice that $\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$

29. Now look at the drawing below. It <u>is not</u> a rhombus.



The measures of the lengths of the sides are written below.

AB is 2 inches long

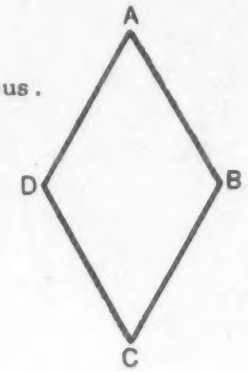
$\overline{DC}$ is 2 inches long

$\overline{BC}$ is 1 inch long

$\overline{AD}$ is 1 inch long

The four lines are not equal in length and so it is not a rhombus.

30. Here is another figure. This <u>is</u> a rhombus.



The measures of the lengths of the sides are written below.

$\overline{AB}$ is 1 inch long

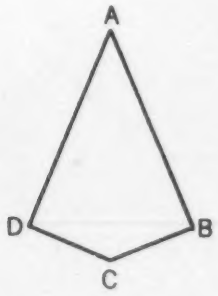
$\overline{AD}$ is 1 inch long

$\overline{DC}$ is 1 inch long

$\overline{BC}$ is 1 inch long

All the lines in this figure are of equal length.

31. Now look at this figure. It <u>is not</u> a rhombus because all sides are not equal.



The measures of the length of the sides are written below.

$\overline{AB}$ is 1-1/4 inches long

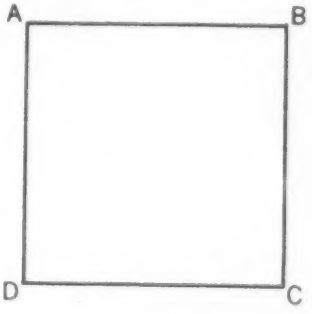
$\overline{AD}$ is 1-1/4 inches long

$\overline{BC}$ is 1/2 inch long

$\overline{DC}$ is 1/2 inch long

All the sides in the figure are not of equal length. Check with your ruler if you wish.

32. This figure <u>is</u> a rhombus. The sides are equal in length. Notice the measures below.



$\overline{AB}$ is 1-1/2 inches long

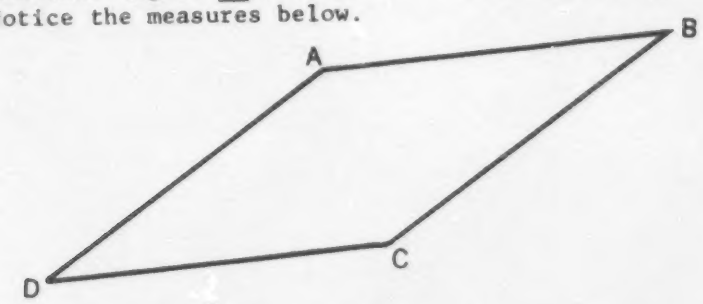
$\overline{AD}$ is 1-1/2 inches long

$\overline{BC}$ is 1-1/2 inches long

$\overline{DC}$ is 1-1/2 inches long

$\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$

33. And this figure <u>is</u> a rhombus. The sides are equal in length. Notice the measures below.



$\overline{AB}$ is 2 inches long

$\overline{AD}$ is 2 inches long

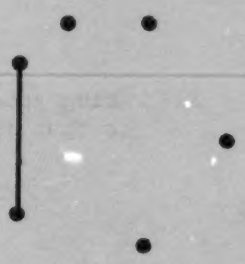
$\overline{BC}$ is 2 inches long

$\overline{DC}$ is 2 inches long

$\overline{AB} = \overline{AD} = \overline{BC} = \overline{DC}$

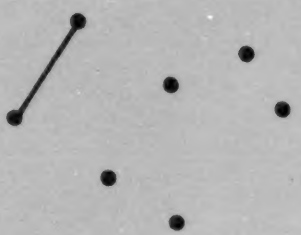
So now you know that when a figure is a quadrilateral there is only one other thing you have to find out to tell whether or not it is a rhombus. You need only find out whether all sides are equal in length. Check the examples you just studied.

34. Using a ruler, connect as many points as you need to close the figure so that all sides are of equal length.



35. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that <u>is not</u> a rhombus.

36. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a rhombus.



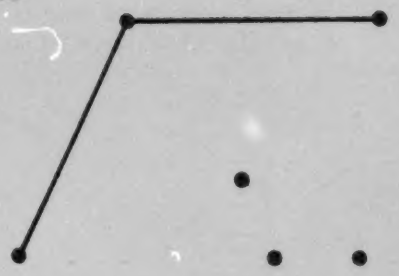
37. All rhombuses have something special that not all quadrilaterals have. Rhombuses have _____ sides that are _____.

_____

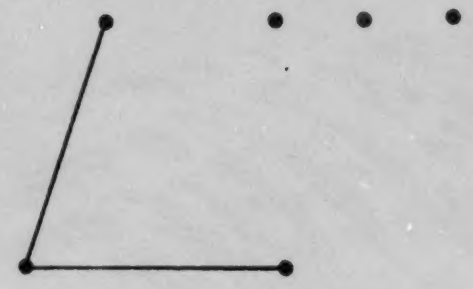
_____

38. List all that is needed to completely describe <u>rhombus</u>.

39. Using your ruler, complete this figure so that it is <u>not</u> a rhombus.



40. Using your ruler, complete this figure so that it <u>is</u> a rhombus.



QUADRILATERAL LESSON II: EXPOSITORY MODE

99

Word List

Some of the words we studied in yesterday's word list were hard ones. Let's look at them again to be sure we know them.

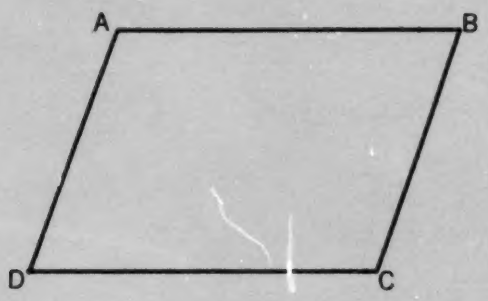
1. quadrilateral
2. trapezoid
3. parallelogram
4. rhombus

Hello,

Yesterday you learned how to tell whether or not a figure is a quadrilateral. You learned that any figure which has four and only four sides is called a quadrilateral. You also learned how to tell whether or not a quadrilateral is a rhombus. You learned that a quadrilateral which has four sides all equal in length is called a rhombus. Today you will learn about two more special kinds of quadrilaterals, parallelograms and trapezoids.

Remember that when learning about these figures you need only look at the sides. Find out if they are the same length or not and whether they are parallel or not. You do not have to think about anything else; like whether the figure is big or small, or thin or fat, or straight or turned around. Just think about the <u>sides</u>. In that way you will learn about the figures.

1. The next special kind of quadrilateral we will study is called a parallelogram. This figure is a parallelogram. A parallelogram has two pairs of parallel sides.



If you use your ruler you will find that sides AB and DC are parallel. You will also find that sides AD and BC are parallel. Opposite sides of a parallelogram are also equal in length. The measures of the line segments in this figure are given below. Use your ruler if you wish to check them.

$\overline{AB}$ is 2 inches long.

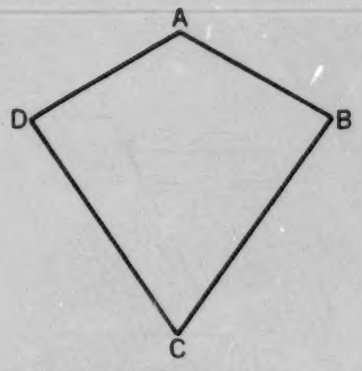
$\overline{DC}$ is 2 inches long.

$\overline{AD}$ is 1-1/2 inches long.

$\overline{BC}$ is 1-1/2 inches long.

Look carefully at the following figures and see how they are alike and how they are different.

2. Look at this figure.



This is not a parallelogram. It does not have 2 pairs of parallel sides. $\overline{AB}$ is not parallel to $\overline{DC}$ and $\overline{AD}$ is not parallel to $\overline{BC}$. Opposite sides are not equal. Check the measures below.

$\overline{AD}$ is 1 inch long.

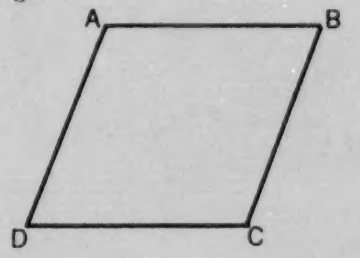
$\overline{AB}$ is 1 inch long.

$\overline{BC}$ is 1-1/2 inches long.

$\overline{DC}$ is 1-1/2 inches long.

$\overline{AB} \neq \overline{DC}$; $\overline{AD} \neq \overline{BC}$. ($\neq$ means not equal to)

3. Now look at this drawing.



This is a parallelogram. It has two pairs of parallel sides. $\overline{AB}$ is parallel to $\overline{DC}$ and $\overline{AD}$ is parallel to $\overline{BC}$. Check with your ruler if you wish. Opposite sides are also equal. The measures of the sides are given below. Check them if you wish.

$\overline{AB}$ is 1-1/4 inches long.

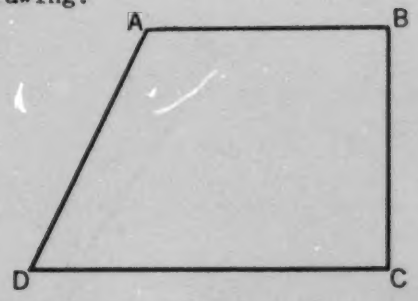
$\overline{DC}$ is 1-1/4 inches long.

$\overline{AD}$ is 1-1/4 inches long.

$\overline{BC}$ is 1-1/4 inches long.

$\overline{AB} = \overline{DC}$ and $\overline{AD} = \overline{BC}$.

4. Here is another drawing.



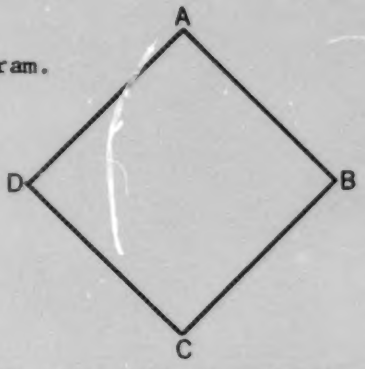
This is not a parallelogram. It does not have two pairs of parallel sides. You will notice that you have one pair of parallel sides but not two pairs.

$\overline{AB}$ and $\overline{DC}$ are parallel.

$\overline{AD}$ and $\overline{BC}$ are not parallel.

Notice also that $\overline{AD}$ is longer than $\overline{BC}$.

5. This figure is a parallelogram.



Look at these measures of the sides and you will see.

$\overline{AB}$ is 1-1/4 inches long.

$\overline{DC}$ is 1-1/4 inches long.

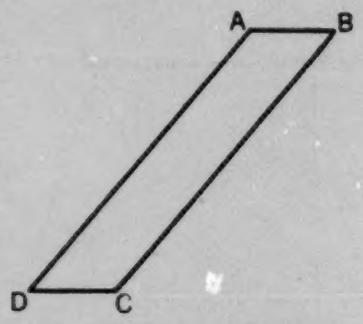
$\overline{BC}$ is 1-1/4 inches long.

$\overline{AD}$ is 1-1/4 inches long.

Notice that $\overline{AB} = \overline{DC}$ and $\overline{BC} = \overline{AD}$.

This figure must have two pairs of parallel sides. If you use your ruler to check you will find that $\overline{AB}$ is parallel to $\overline{DC}$ and $\overline{BC}$ is parallel to $\overline{AD}$.

6. And this <u>is</u> a parallelogram. It has two pairs of parallel sides. Opposite sides are also equal.



Check the measures of the sides written below.

$\overline{AB}$ is 1/2 inch long.

$\overline{DC}$ is 1/2 inch long.

$\overline{BC}$ is 2 inches long.

$\overline{AD}$ is 2 inches long.

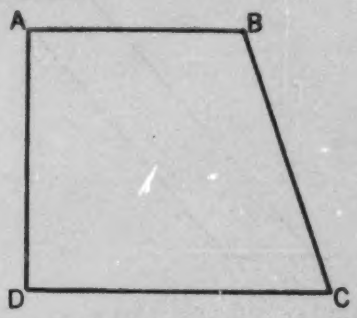
If <u>you</u> use <u>your</u> ruler you <u>will</u> find that $\overline{AB}$ is parallel to $\overline{DC}$ and $\overline{AD}$ is parallel to $\overline{BC}$.

You know that all the figures in questions 1, 2, 3, 4, 5, and 6 are quadrilaterals. There are two ways you can tell whether or not they are parallelograms:

1. If there are two pairs of parallel sides; and

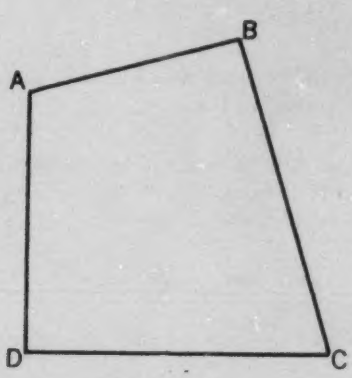
2. If opposite sides are equal in length.

7. The last special kind of quadrilateral we will study is a trapezoid. This figure is a trapezoid. One pair of sides is parallel. All trapezoids have one pair and only one pair of parallel sides.



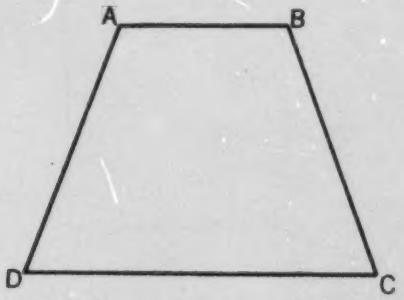
Look at it carefully and use your ruler to check that sides AB and DC are parallel. AD and BC are not parallel.

8. Look at this figure now. It is not a trapezoid. Side AB is not parallel to side DC and side AD is not parallel to side BC.



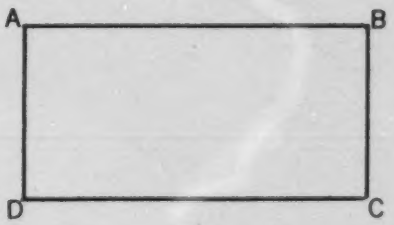
Use your ruler to check that sides AB and DC in this problem are not parallel. AD and BC are not parallel either. Check if you wish.

9. The next figure <u>is</u> a trapezoid. Look at it carefully and see how it is like the figure in question 7 and different from the figure in question 8.



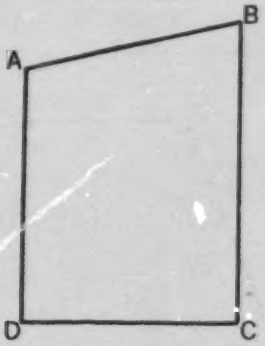
Use your ruler again and you will find out that sides AB and DC in this problem are parallel, like sides AB and DC in question 7. They are different from sides AB and DC in question 8, since those sides were not parallel. You will also find that AD and BC are not parallel.

10. Here is another figure.



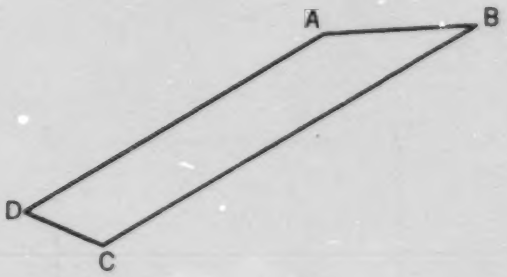
This <u>is not</u> a trapezoid. If you check the sides you will find that side AB is parallel to side DC. You will find also that side AD is parallel to side BC. The figure has two pairs of parallel sides. We said that a trapezoid has one pair and only one pair of parallel sides. This figure has two pairs of parallel sides so it is not a trapezoid.

11. Now look at this figure. This is a trapezoid.



Are you surprised? Remember that in a trapezoid only one pair of sides is parallel. $\overline{AD}$ is parallel to $\overline{BC}$ and $\overline{AB}$ is not parallel to $\overline{DC}$. Use your ruler again to check this.

12. This figure is a trapezoid, too.

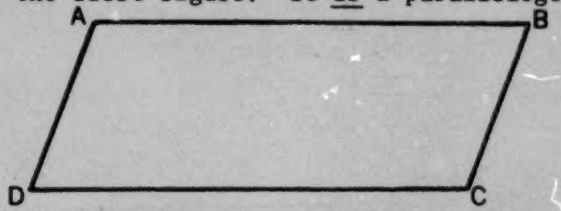


Would you have known? Remember that trapezoids have one and only one pair of parallel sides. In this figure $\overline{AD}$ is parallel to $\overline{BC}$ and $\overline{AB}$ is not parallel to $\overline{DC}$.

You could tell that the figures in questions 7, 8, 9, 10, 11 and 12 are quadrilaterals because they have four lines. The other thing you have to know to tell whether or not they are trapezoids is that one pair of sides, and only one pair, is parallel.

13. The first six figures you studied (questions 1 to 6) were to help you learn how to tell whether or not a figure was a parallelogram. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a parallelogram. First, we must be sure you can remember the word parallelogram itself. Repeat it several times to yourself: parallelogram, parallelogram, parallelogram. Now write the word parallelogram here. _____ Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

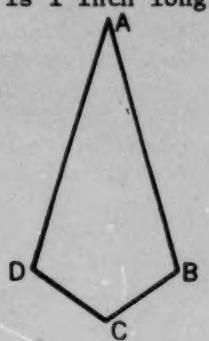
14. Here is the first figure. It <u>is</u> a parallelogram.



If you use your ruler you will find that sides AB and DC are parallel. You will also find that sides AD and BC are parallel. Opposite sides of a parallelogram are also equal. The measures of the sides in this figure are given below. Use your ruler if you wish to check them.

$\overline{AB}$ is 2-1/2 inches long.
$\overline{DC}$ is 2-1/2 inches long
$\overline{AD}$ is 1 inch long.
$\overline{BC}$ is 1 inch long.

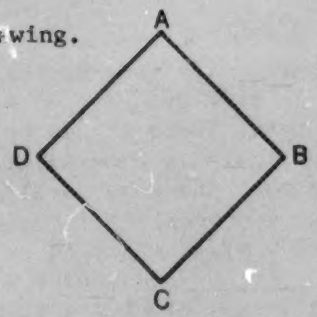
15. Look at this figure.



This is not a parallelogram. It does not have 2 pairs of parallel sides. $\overline{AB}$ is not parallel to $\overline{DC}$ and $\overline{AD}$ is not parallel to $\overline{BC}$. Opposite sides are not equal. Check the measures below.

$\overline{AB}$ is 1-1/2 inches long.
$\overline{DC}$ is 1/2 inch long.
$\overline{AD}$ is 1-1/2 inches long.
$\overline{BC}$ is 1/2 inch long.
$\overline{AB} \neq \overline{DC}$; $\overline{AD} \neq \overline{BC}$

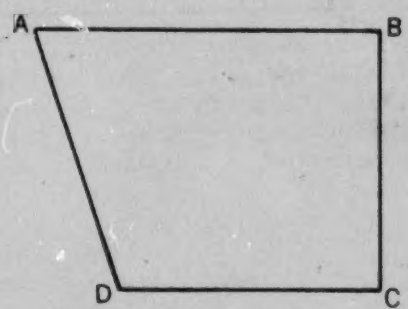
16. Now look at this drawing.



This is a parallelogram. It has two pairs of parallel sides. $\overline{AB}$ is parallel to $\overline{DC}$ and $\overline{AD}$ is parallel to $\overline{BC}$. Check with your ruler if you wish. Opposite sides are also equal. The measures of the sides are given below. Check them if you wish.

$\overline{AB}$ is 1 inch.
$\overline{DC}$ is 1 inch.
$\overline{AD}$ is 1 inch.
$\overline{BC}$ is 1 inch.

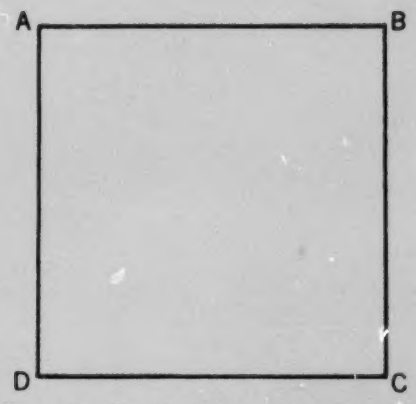
17. Here is another drawing.



This <u>is not</u> a parallelogram. It does not have two pairs of parallel sides. Notice that it has one pair of parallel sides but not two pairs.

$\overline{AB}$ is parallel to $\overline{DC}$.
$\overline{AD}$ is not parallel to $\overline{BC}$.

18. And now look at this figure.



This figure is a parallelogram. Look at these measures of the sides and you will see.

$\overline{AB}$ is 2 inches long.
$\overline{DC}$ is 2 inches long.
$\overline{AD}$ is 2 inches long.
$\overline{BC}$ is 2 inches long.

19. And this is a parallelogram. It has two pairs of parallel sides. Opposite sides are also equal.

Check the measures of the sides written below.

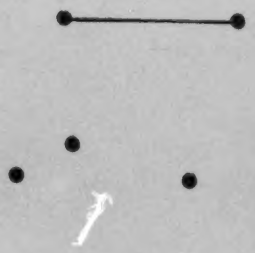
$\overline{AB}$ is 2 1/2 inches long.
$\overline{DC}$ is 2 1/2 inches long.
$\overline{AD}$ is 1/2 inch long.
$\overline{BC}$ is 1/2 inch long.

If you use your ruler you will find that $\overline{AB}$ is parallel to $\overline{DC}$ and $\overline{AD}$ is parallel to $\overline{BC}$.

You know that the last six figures are all quadrilaterals. There are two ways you can tell whether or not they are parallelograms.

1. If there are two pairs of parallel sides; or
2. If opposite sides are equal in length.

20. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that <u>is</u> <u>not</u> a parallelogram.



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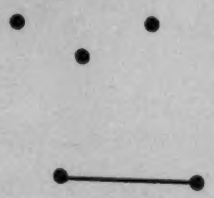
21. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a parallelogram.



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22. All parallelograms have something special that not all quadrilaterals have. Parallelograms have _____ pair(s) of _____ sides.

_____

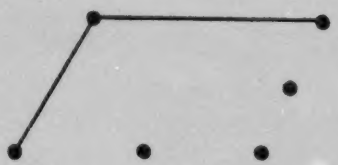
_____

---

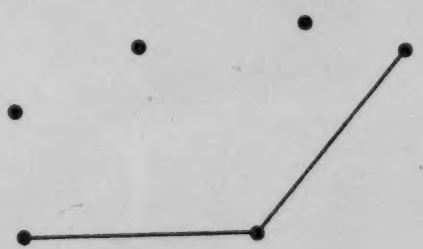
23. List all that is needed to completely describe <u>parallelogram</u>.

24. Using a ruler, connect as many points as needed to close the figure so it has 2 pairs of parallel sides.

25. Using a ruler, complete this figure so that it is a quadrilateral but <u>not</u> a parallelogram.



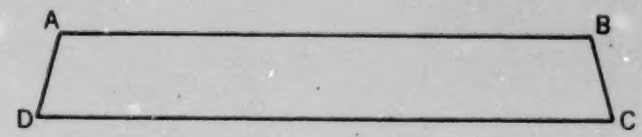
26. Using your ruler, complete this figure so that it <u>is</u> a parallelogram.



27. In questions 7 to 12 there were six figures which you studied to help you learn to tell whether or not a figure is a trapezoid. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a trapezoid. First we must be sure you can remember the word trapezoid itself. Repeat it several times to yourself: trapezoid, trapezoid, trapezoid. Now write the word trapezoid here. _____

Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and also how they are alike.

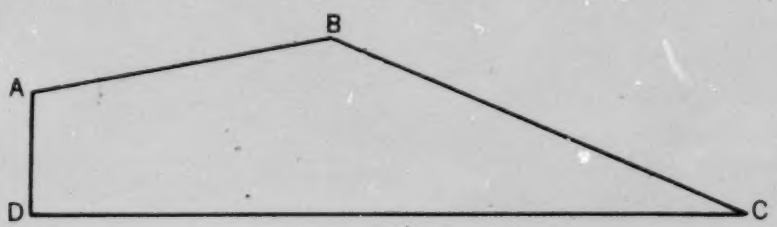
28. Here is the first figure. This <u>is</u> a trapezoid.



Look at it carefully and use your ruler to check the sides.

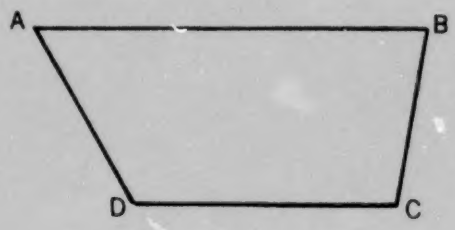
$\overline{AB}$ is parallel to $\overline{DC}$
$\overline{AD}$ is not parallel to $\overline{BC}$

29. Look at this figure now. It <u>is not</u> a trapezoid.



Use your ruler if you wish to check that sides $\overline{AB}$ and $\overline{DC}$ are not parallel. $\overline{AD}$ and $\overline{BC}$ are not parallel either.

30. The next figure <u>is</u> a trapezoid.

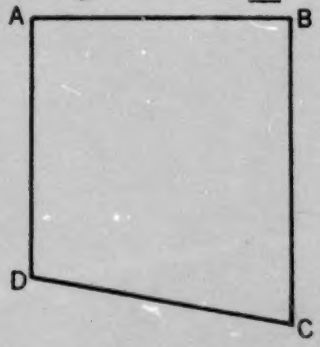


Use your ruler again and you will find that sides AB and DC are parallel. Sides AD and BC are not parallel.

31. Here is another figure.

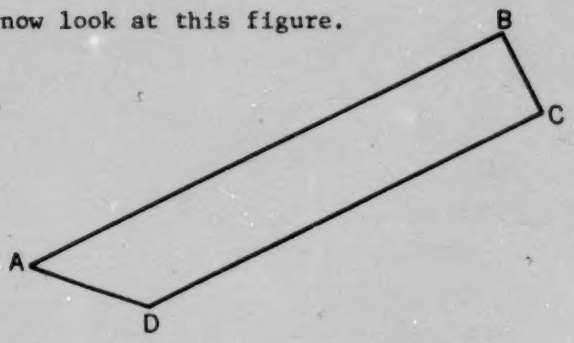
This <u>is not</u> a trapezoid. If you check the <u>sides</u> with <u>your ruler you will</u> find that $\overline{AB}$ is parallel to $\overline{DC}$ and that $\overline{AD}$ is parallel to $\overline{BC}$. The figure has two pairs of parallel sides. We said that a trapezoid has one pair and only one pair of parallel sides. This figure has two pairs of parallel sides so it is not a trapezoid.

32. Now look at this figure. This is a trapezoid.



Remember that in a trapezoid only one pair of sides are parallel. $\overline{AD}$ is parallel to $\overline{BC}$ and $\overline{AB}$ is not parallel to $\overline{DC}$. Use your ruler again to check this.

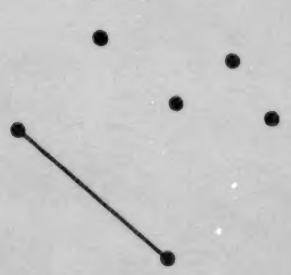
33. And now look at this figure.



This is a trapezoid. $\overline{AB}$ is parallel to $\overline{DC}$ but $\overline{BC}$ is not parallel to $\overline{AD}$.

In the last six figures you knew that all of them were quadrilaterals. To tell whether or not a quadrilateral is a trapezoid all you have to find out is whether the figure has one and only one pair of parallel sides.

34. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a trapezoid.



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35. All trapezoids have something special that not all quadrilaterals have. Trapezoids have _____ pair(s) of _____ sides.

_____

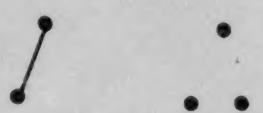
_____

---

36. List all that is needed to completely describe <u>trapezoid</u>.

---

37. Using a ruler, connect as many points as needed to close the figure so it has only 1 pair of sides parallel.



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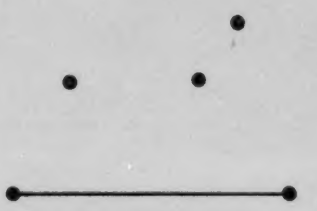
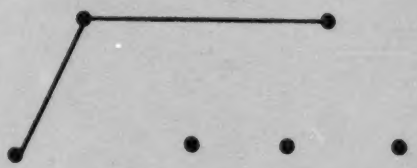
38. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that is <u>not</u> a trapezoid.



39. Using a ruler, complete this figure so that it is a quadrilateral but <u>not</u> a trapezoid.



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40. Using a ruler, complete this figure so that it <u>is</u> a trapezoid.

TRIANGLE LESSON: DISCOVERY MODE

Word List

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

1. triangle
2. polygon
3. right angle triangle
4. acute angle triangle
5. obtuse angle triangle
6. equilateral triangle
7. isosceles triangle

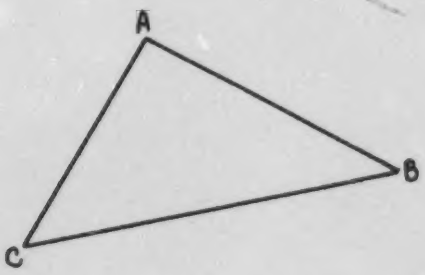
Hello,

You are now ready to start your third lesson. This lesson is not quite like the last two lessons. You have been told about the difference in the form of these lessons. Now we want to point out some things to keep in mind as you go through this and the following lessons.

You may have noticed that the last two lessons were about lines and parts of lines (that is, line segments and rays) and about angles. You learned how to tell whether or not two lines are parallel. And you learned how to tell a right angle, an acute angle and an obtuse angle apart. As you study the figures in this and the following lessons you will use what you learned.

To learn about the figures in the next lesson you will only have to learn about the line segments (or sides, as we will call them) and the angles. When you are learning about a figure look at the sides, find out if they are the same length, and find out whether they are parallel. Look at each angle and check whether it is a right angle or an acute angle or an obtuse angle. You do not have to think of anything else like whether it is big or small, or thin or fat, or straight or turned around. Just think about the <u>sides</u> and the <u>angles</u> and you will learn about the figures.

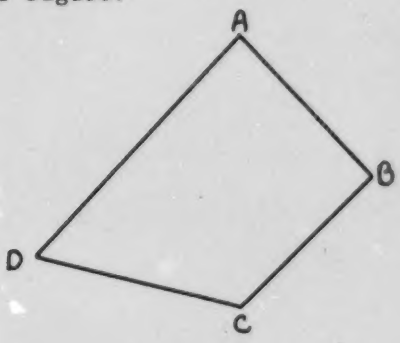
1. Triangles are special kinds of polygons. The next six figures will help you to tell whether or not a polygon is a <u>triangle</u>. Look at them carefully and notice how the figures are alike and how they are different. Here is the first figure.



Look at it. Describe it by saying how many sides it has. How many sides does it have? _____

_____

2. Here is another figure.

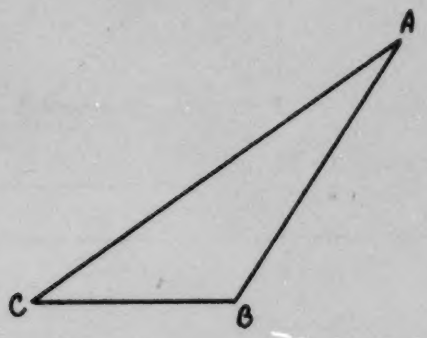


How many sides does it have? _____

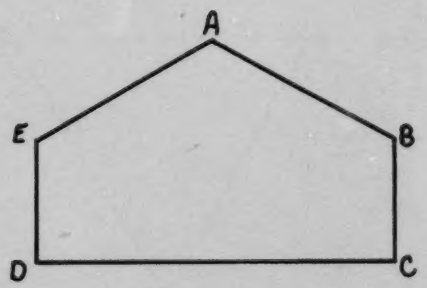
_____

3. Look at the next drawing. How many sides does it have?

_____



4. Now look at this figure.

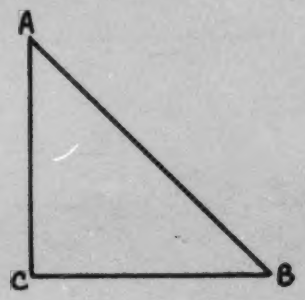


How many sides does it have? _____

_____

123

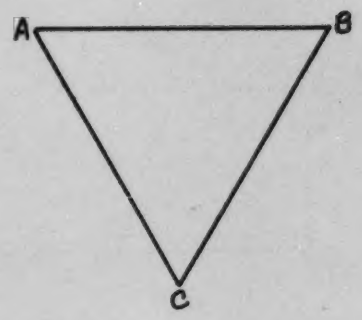
5. Now look at this drawing.



How many sides does it have? _____

_____

6. Here is another figure.



How many sides does it have? _____

_____

7. In the last six examples, four were alike and two were different. What are the numbers of the four which were alike? _____

1, 3, 5, 6

8. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or angles or both. Say how you think the four figures you named in the last question were alike.

_____

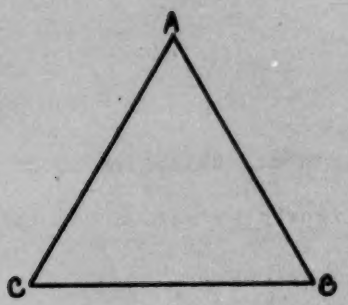
_____

_____

_____

All had three sides. Figures which have three and only three sides are called <u>triangles</u>.

9. In the rest of this lesson you will be studying about special kinds of triangles. One special kind of triangle is called an <u>equilateral triangle</u>. The four figures following will help you to tell whether or not a figure is an equilateral triangle. Look at them carefully and note how they are alike and how they are different. Here is the first figure.



Measure the sides with your ruler and write what you find here.

The side AB is _____ inches long.

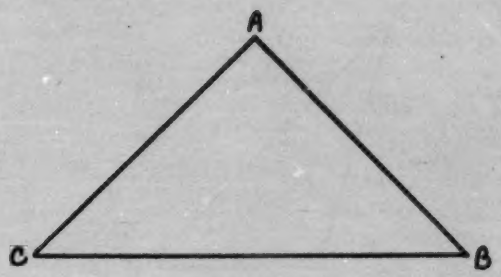
The side AC is _____ inches long.

The side CB is _____ inches long.

What do you notice about the lengths of the sides? _____

_____

10. Now look at this figure.



Measure the sides.

Side AB is _____ inches long.

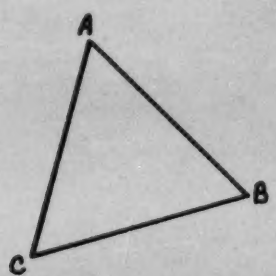
Side AC is _____ inches long.

Side CB is _____ inches long.

What did you notice about the lengths of the sides? _____

_____

11. Here is another drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

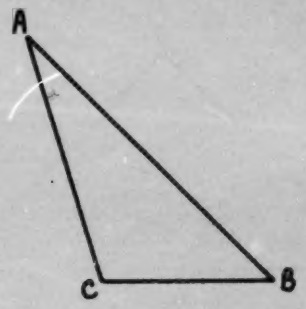
$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

What do you notice about the sides? _____

_____

12. Look at this figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

How are this figure and the figure in question 10 different from the figures in questions 9 and 11? _____

_____

13. Two of the last four figures were alike and two were not. What are the numbers of the two which were alike?

_____

9, 11

14. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or angles or both. Say how you think that the two figures you named in the last question were alike. _____

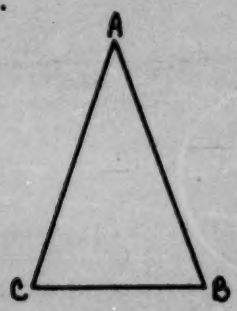
_____

_____

_____

The three sides were equal in length. Triangles whose three sides are equal in length are called <u>equilateral triangles</u>.

15. Another kind of triangle is an <u>isosceles triangle</u>. The following six figures will help you learn how to tell whether or not a figure is an isosceles triangle. Look carefully at them and notice how they are alike and how they are different. Here is the first figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

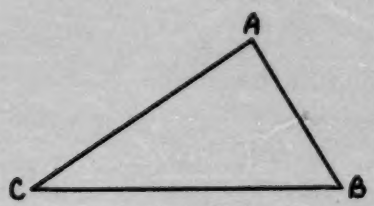
$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

What do you notice about the lengths of the sides? _____

_____

16. Look at the drawing below.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AC}$ is _____ inches long.

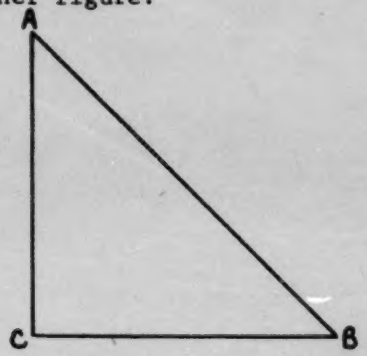
$\overline{CB}$ is _____ inches long.

What do you notice about the sides in this figure? _____

_____

How are the sides in this figure different from the sides in the last figure? _____

17. Here is another figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

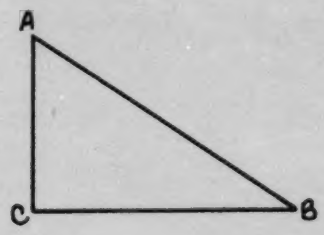
What do you notice about the lengths of the sides? _____

_____

How are the sides in this figure like the sides in the figure in question 15? _____

_____

18. And here is another figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

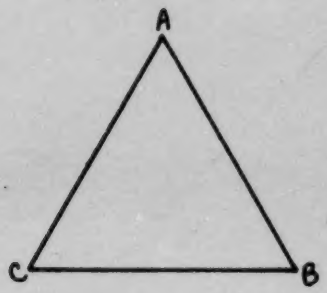
$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

What do you notice about these sides? _____

_____

19. Look at this drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

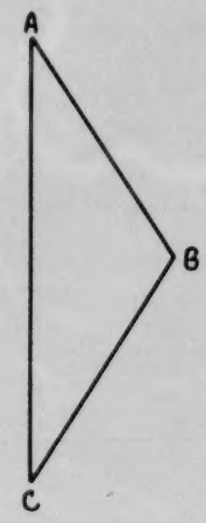
$\overline{AC}$ is _____ inches long.

$\overline{CB}$ is _____ inches long.

What do you notice about the sides? _____

_____

20. And look at this figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AC}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

What do you notice about the sides? _____

_____

How are the sides in this figure like the sides in the figures in questions 15 and 17? _____

_____

21. Four of the last six figures were alike and two were not. What are the numbers of figures which were alike? _____

15, 17, 19, 20

22. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or the angles or both. Say how you think that the four figures you named in the last question were alike. _____

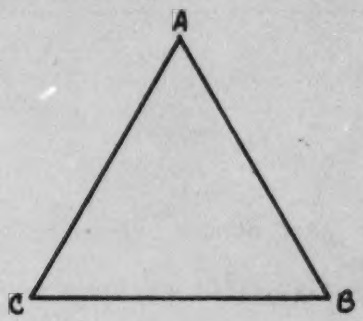
_____

_____

_____

Two of the sides were equal in length. Triangles which have two sides equal in length are called <u>isosceles triangles</u>.

23. Another special kind of triangle is called an <u>acute angle triangle</u>. The following six figures will help you to learn how to tell whether or not a triangle is an acute angle triangle. Look carefully at the figures and see how they are alike and how they are different.



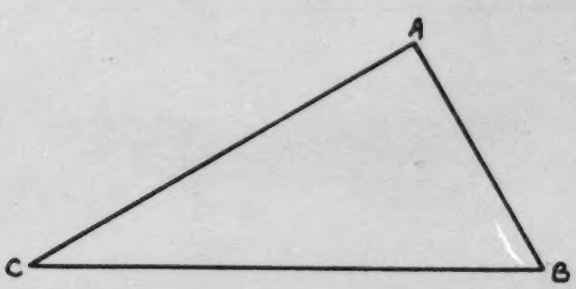
Name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

24. Now look at this figure.



Name the angles.

The angle at A is _____

The angle at B is _____

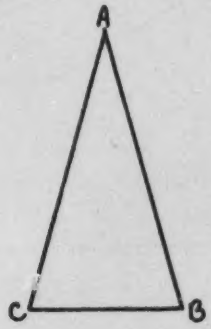
The angle at C is _____

What did you notice about the angles? _____

_____

How are they different from the angles in the figure in question 23? _____

25. Here is another figure. Look at it carefully and see how it is like the figure in question 23 and different from the figure in question 24.



Name the angles.

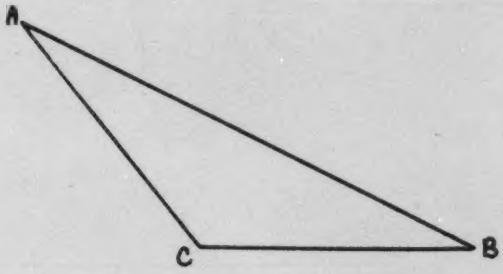
The angle at A is _____

The angle at B is _____

The angle at C is _____

How are the angles in this figure like those in the figure in question 23? _____

26. Here is still another figure.



Name the angles.

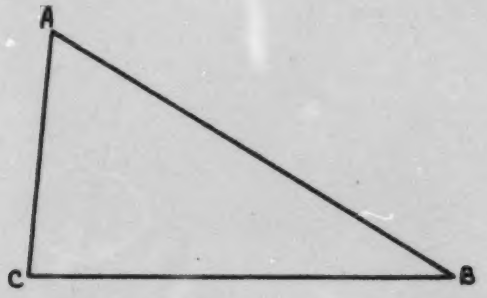
The angle at A is _____

The angle at B is _____

The angle at C is _____

How are the angles in this figure different from the angles in the figure in the last question? _____

27. Now look at this figure.



Name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

Are the angles in this figure like the angles in the figure in the last question? _____

28. And look at this figure.

Name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

How are the angles in this figure like those in the last figure? _____

_____

29. Four of the last six figures were alike and two were not. What are the numbers of the four figures which were alike? _____

23, 25, 27, 28

30. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or the angles or both. Say how you think that the four figures you named in the last question were alike. _____

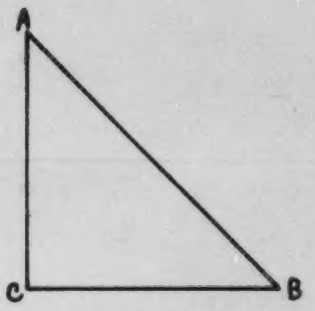
_____

_____

_____

All had three acute angles. Triangles with three acute angles are called acute angle triangles.

31. Still another special kind of triangle is called a <u>right angle triangle</u>. The next six figures will help you learn whether or not a figure is a right angle triangle. Look at them carefully and note how they are alike and how they are different. Here is the first figure.



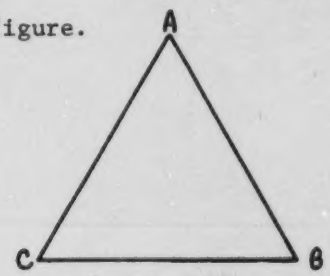
Look at it. Use your ruler as you learned in the first lesson to help you name tne three angles in this figure. Give a name to the three angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

32. Now look at this figure.



Look at it. Use your ruler to help you name the three angles. Write the names of the angles here.

The angle at A is _____

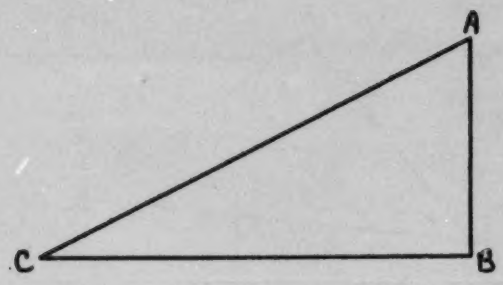
The angle at B is _____

The angle at C is _____

How is this figure different from the figure in the last question?

Look carefully at the angles. _____

33. Here is another figure.



Use your ruler to check the angles.

The angle at A is _____

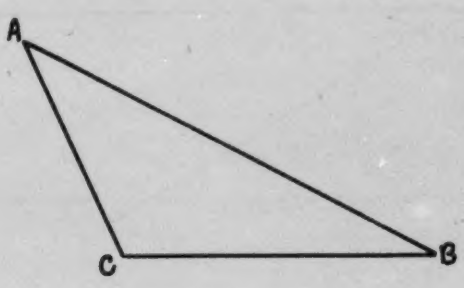
The angle at B is _____

The angle at C is _____

How is this figure like the figure in Question 31? _____

_____

34. Look at this figure.



Name the angles.

The angle at A is _____

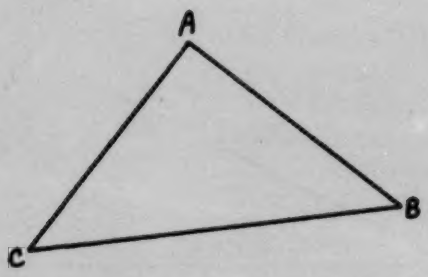
The angle at B is _____

The angle at C is _____

How is this figure different from the figure in the last question?

_____

35. Now look at this figure.



Name the angles. Use your ruler to help you.

The angle at A is _____

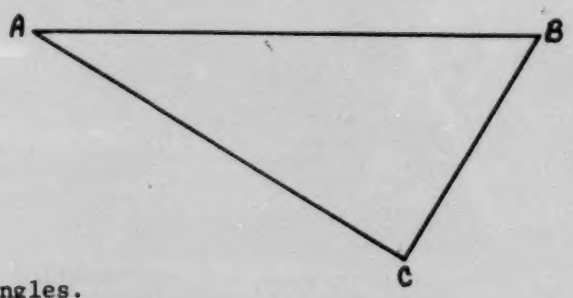
The angle at B is _____

The angle at C is _____

How is this figure like the figure in Question 33? _____

_____

36. And here is another figure.



Name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

140

37. Four of the last six figures were alike and two were not. What are the numbers of the four figures which were alike? _____

31, 33, 35, 36

38. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or the angles or both. Say how you think that the four figures you named in the last question were alike. _____

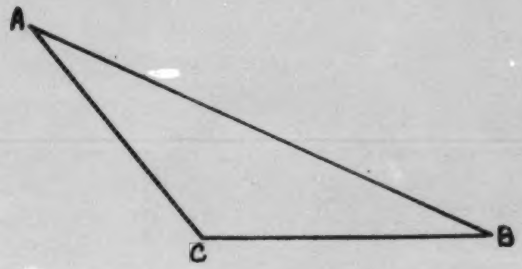
_____

_____

_____

They had one right angle. Triangles which have one right angle are called right angle triangles.

39. The last kind of triangle we will study is called an obtuse angle triangle. The next six figures should help you to tell whether or not a figure is an obtuse angle triangle. Look carefully at them and note how they are alike and how they are different.



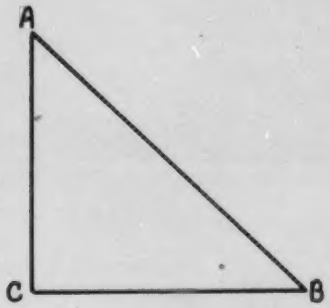
Use your ruler to name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

40. Look at this figure.



Name the angles. Use your ruler if you wish.

The angle at A is _____

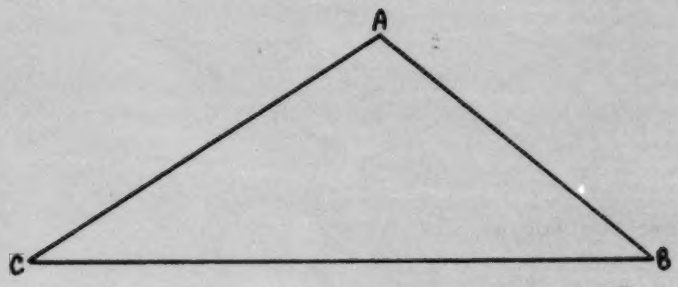
The angle at B is _____

The angle at C is _____

How are the angles in this figure different from those in the figure in question 39? _____

_____

41. Now look at this drawing.



Name the angles.

The angle at A is _____

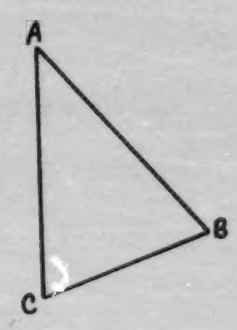
The angle at B is _____

The angle at C is _____

How is this figure like the figure in question 39? _____

_____

42. Here is another drawing.



Name the angles.

The angle at A is _____

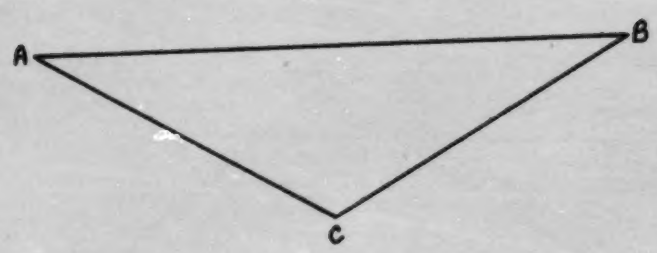
The angle at B is _____

The angle at C is _____

Can you see how it is different from the figure in question 41? Use your ruler to check if you wish and then write how you think this figure is different from the figure in question 41.

_____

43. Look at this figure.



Name the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

Check. Write what you find about the angles here. _____

_____

44. And here is another figure.

Check the angles.

The angle at A is _____

The angle at B is _____

The angle at C is _____

How are the angles in this triangle like the angles in the last question? _____

45. Four of the last six figures were alike and two were not. What are the numbers of the four figures which are alike? _____

39, 41, 43, 44

46. Remember what we said at the beginning of the lesson about describing figures by saying something about either the sides or the angles or both. Say how you think that the four figures you named in the last question were alike. _____

_____

_____

_____

They had one obtuse angle. Triangles which have one obtuse angle are called <u>obtuse angle triangles</u>.

QUADRILATERAL LESSON I: DISCOVERY MODE

Word List

Look carefully at each word as I read it to you. Then say the word aloud with me when I repeat it.

1. quadrilateral
2. trapezoid
3. parallelogram
4. rhombus

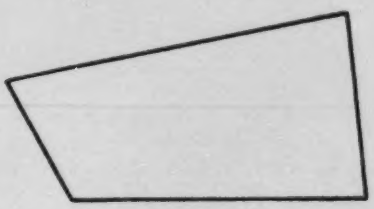
Hello,

This lesson is not quite like the last lessons. You have been told about the difference in the form of these lessons. Now we want to point out some things to keep in mind as you go through this and the following lessons.

You may have noticed that the last two lessons were about lines and parts of lines (that is, line segments and rays). You learned how to tell whether or not two lines are parallel. As you study the figures in this and the following lessons, you will use what you learned.

To learn about the figures in the next lesson you will only have to learn about the line segments, or <u>sides</u> as we will call them. When you are learning about a figure, look at the sides. Find out if they are the same length or not and if they are parallel or not. You do not have to think of anything else about the figure , such as whether it is big or small, or thin or fat, or straight or turned around. Just think about the <u>sides</u>. That is how you will learn about the figure.

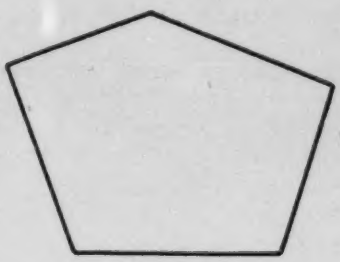
1. This section has six figures in it. You will learn from studying these figures how to tell whether a polygon is a quadrilateral or not. Look carefully at the polygons shown in the following questions. Notice how they are alike and how they are different. Some of these are quadrilaterals. Others are not. Here is the first figure.



Look at it. Describe it by giving the number of sides. How many sides does it have?

_____

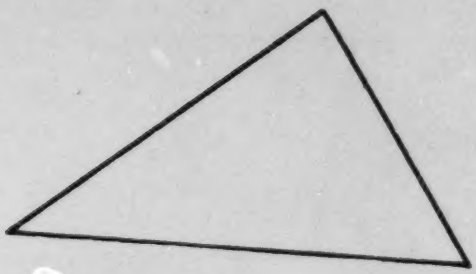
2. Here is another figure.



How many sides does it have? _____

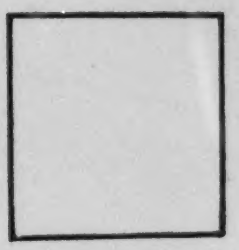
3. Look at the next drawing. How many sides does it have?_____

4. Look at this drawing.



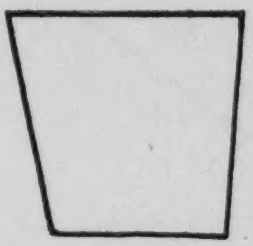
How many sides does it have?_____

5. Here is another drawing. Count the sides.



How many sides does it have?_____

6. Now look at this figure.



How many sides does it have?_____

7. In the last six examples, four were alike and two were different. What are the numbers of the four which were alike?

_____

1, 3, 5, 6

8. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question were alike.

_____

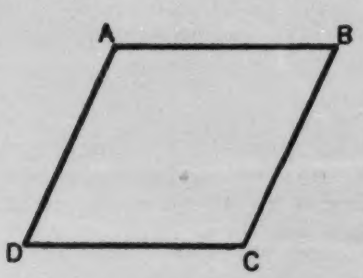
_____

_____

All had four sides.

The four figures which are alike are quadrilaterals.

9. One special kind of quadrilateral is a rhombus. The following six figures will help you tell whether or not a quadrilateral is also a rhombus. Look at them carefully and note how they are alike and how they are different. Here is the first figure.



Use your ruler to measure the lengths of the sides and write the lengths here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

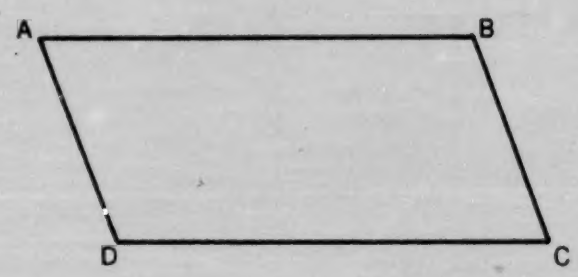
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What did you notice about the length of the sides? _____

_____

10. Now look at this figure.



Measure lengths of the sides and write them here.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

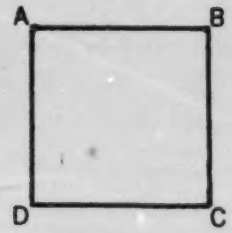
$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

You can see how this figure is different from the figure in the last question. Write how it is different. _____

_____

11. Here is another figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

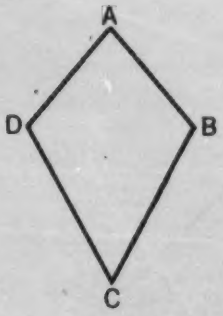
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

How is this figure like the one in question 9 and different from the one in question 10? _____

_____

12. Now look at this figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

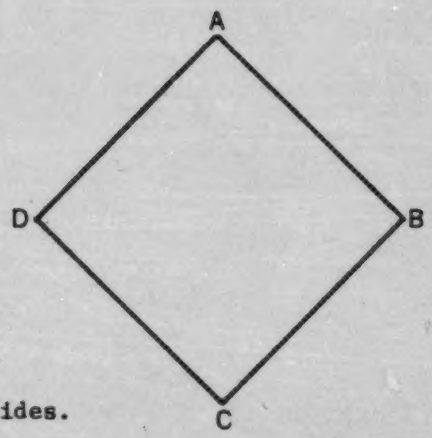
$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

How is this figure different from the figure in the last question?

_____

13. Here is another figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

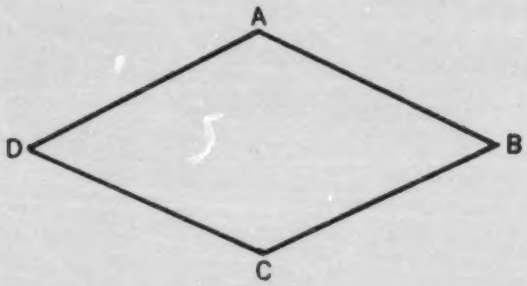
$\overline{DC}$ is _____ inches long.

How is this figure like the figures in questions 9 and 11?

_____

_____

14. And here is another figure.



Write the length of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What do you notice about the lengths of the sides? _____

_____

15. In the last six figures, four were alike and two were different. What are the numbers of the four which were alike? _____

_____

9, 11, 13, 1

16. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question were alike? _____

All four sid
were equal i
length.

_____

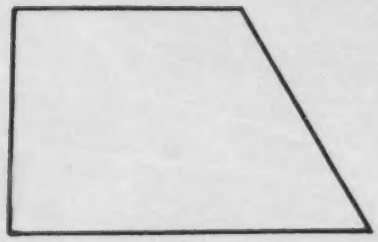
_____

Each of the four figures which are alike is called a rhombus.

17. The first six figures you studied (questions 1 to 6) were to help you learn how to tell whether or not a figure was a quadrilateral. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a quadrilateral. First, we must be sure you can remember the word quadrilateral itself. Repeat it several times to yourself: quadrilateral, quadrilateral, quadrilateral. Now write the word quadrilateral here._____

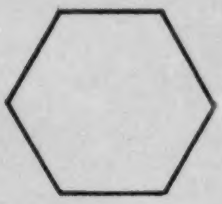
Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

18. Here is the first figure.



Look at it. Describe it by giving the number of sides it has.
How many sides does it have?_____

19. **Here is another figure.**



How many sides does it have? _____

How is this figure different from the figure in the last question?

_____

20. Look at the next figure.

How many sides does it have? _____

How is it different from the last figure? _____

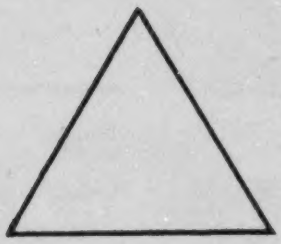
_____

_____

How is it like the figure in question 18? _____

_____

21. Look at this drawing.



How many sides does it have?_____

How is the figure different from the figure in question 20?

_____

_____

22. Here is another figure. Count the sides.

How many sides does it have?_____

How is this figure like the figures in questions 18 and 20?

_____

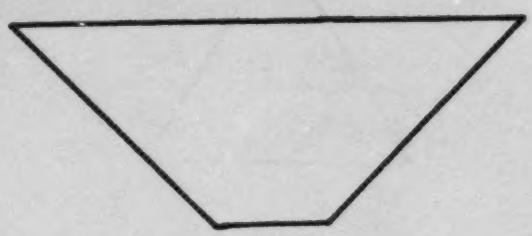
_____

How is this figure different from the figure in question 21?

_____

_____

23. And look at this figure.



How many sides does it have? _____

_____

How is this figure like the figure in question 22? _____

_____

_____

24. In the last six examples, four were alike and two were different. What are the question numbers of the four which were alike?_____

18, 20, 22, 23

25. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question were alike. _____

_____

All had four sides. Every figure which has four and only four sides is called a <u>quadrilateral</u>.

26. Using a ruler, connect as many points as you need to close the figure so that it is <u>not</u> a quadrilateral.

---

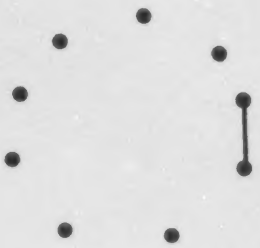
27. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a quadrilateral.

---

28. How many sides do quadrilaterals have? _____

---

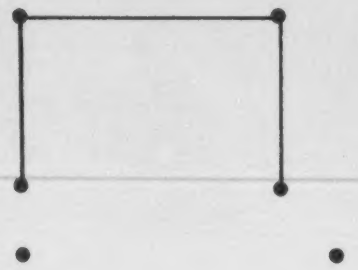
29. Using a ruler, connect as many points as needed to close the figure so it has only 4 sides.



30. List all that is needed to completely describe quadrilateral.

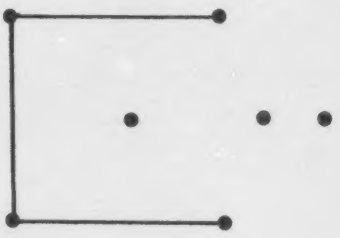
---

31. Using a ruler, complete this figure so that it is not a quadrilateral.



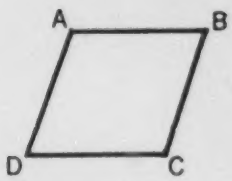
---

32. Using a ruler, complete this figure so that it is a quadrilateral.



33. In questions 9 to 14 there were six figures which you studied to help you learn to tell whether or not a figure is a rhombus. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a rhombus. First we must be sure you can remember the word rhombus itself. Repeat it several times to yourself: rhombus, rhombus, rhombus. Now write the word rhombus here._____
Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

34. Here is the first figure.



Use your ruler to measure the length of the sides and write the lengths here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

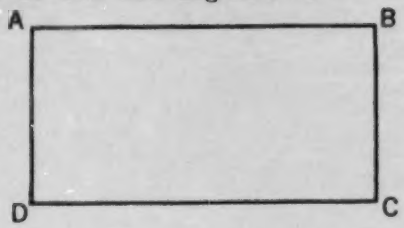
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What did you notice about the lengths of the sides?_____

_____

35. Now look at the drawing below.



Measure the lengths of the sides and write them here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

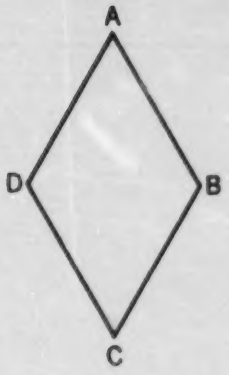
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

You can see how this figure is different from the figure in the last question. Write how it is different._____

_____

36. Here is another figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

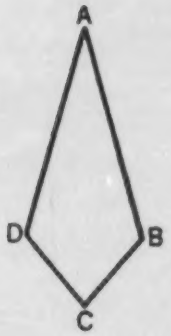
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

How is this figure like the one in question 34 and different from the one in question 35?_____

_____ _____

37. Now look at this figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

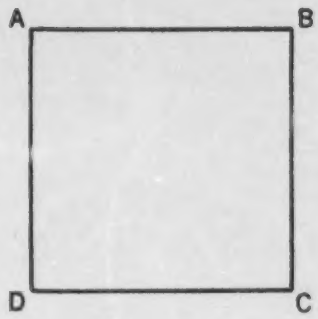
$\overline{DC}$ is _____ inches long.

How is this figure different from the figure in the last question?

_____

_____

38. Now look at this figure.



Measure the sides and write the lengths here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

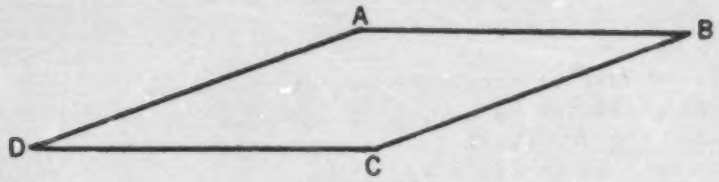
$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

How is this figure like the figure in que tions 34 and 36?_____

_____

39. And here is another figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What do you notice about the lengths of the sides? _____

_____

40. In the last six examples, four were alike and two were different. What are the numbers of the four which were alike? _____

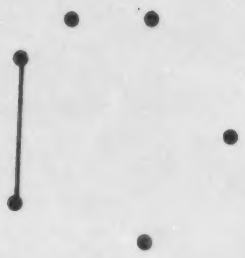
34, 36, 38, 39

41. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question are alike. _____

_____

The four sides of each of them are equal in length. Every quadrilateral which has four sides equal in length is called a rhombus.

42. Using a ruler, connect as many points as you need to close the figure so that all sides are of equal length.



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43. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that <u>is</u> <u>not</u> a rhombus.

---

44. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a rhombus.

---

45. All rhombuses have something special that not all parallelograms have. Rhombuses have _____ sides that are _____.

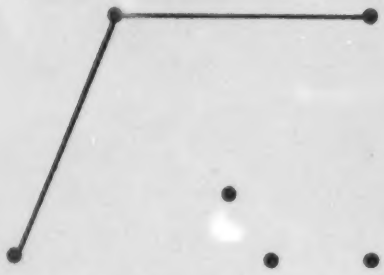
_____

_____

---

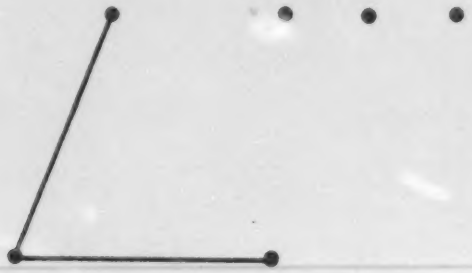
46. List all that is needed to completely describe <u>rhombus</u>.

47. Using your ruler, complete this figure so that it <u>is</u> <u>not</u> a rhombus.



---

48. Using your ruler, complete this figure so that it <u>is</u> a rhombus.



QUADRILATERAL LESSON II: DISCOVERY MODE

Word List

Some of the words we studied in yesterday's word list were hard ones. Let's look at them again to be sure we know them.

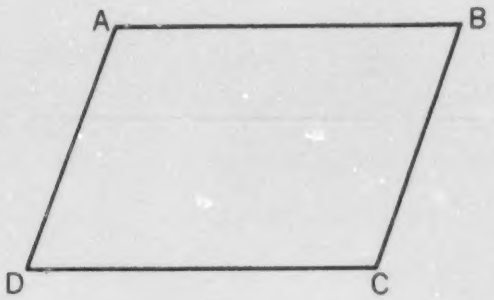
1. quadrilateral
2. trapezoid
3. parallelogram
4. rhombus

Hello,

Yesterday you learned how to tell whether or not a figure is a quadrilateral. You learned that any figure which has four and only four sides is called a quadrilateral. You also learned how to tell whether or not a quadrilateral is a rhombus. You learned that a quadrilateral which has all four sides equal in length is called a rhombus. Today you will learn about two more special kinds of quadrilaterals, parallelograms and trapezoids.

Remember that when learning about these figures you need only look at the sides. Find out if they are the same length or not and if they are parallel or not. You do not have to think about anything else like whether the figure is big or small, or thin or fat, or straight or turned around. Just think about the sides. In that way you will learn about the figures.

1. The next special kind of quadrilateral we will study is called a <u>parallelogram</u>. The next six problems will help you tell whether or not a figure is a parallelogram. Look at them carefully and notice how the figures are alike and how they are different. **Here is the first figure.**



Use your ruler to find out some things about sides AB and DC. Did you measure them? How long are they?

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What else did you notice about $\overline{AB}$ and $\overline{DC}$? Check again and write what you find out here._____

_____

What about $\overline{AD}$ and $\overline{BC}$?

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

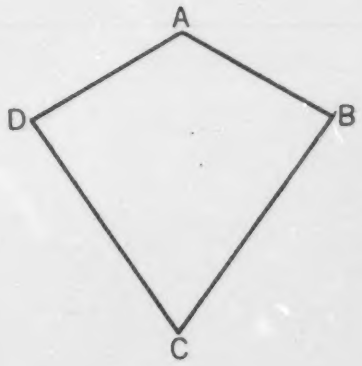
What else did you notice about $\overline{AD}$ and $\overline{BC}$? _____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

2. Look at this figure.



Measure sides AB, AD, BC, and DC.

$\overline{AD}$ is _____ inches long.

$\overline{AB}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

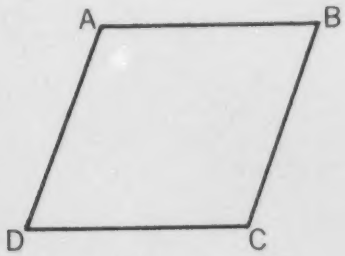
Is $\overline{AB}$ parallel to $\overline{DC}$? _____

How is this figure different from the figure in the last question?

_____

_____

3. Now look at this drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

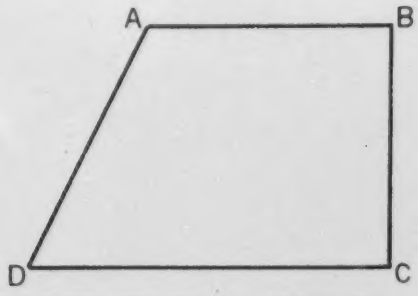
How is this different from the last figure? _____

_____

How is it like the figure in Question 1? _____

_____

4. Here is another drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

Can you see how this is different from the figure in Question 3?

Use your ruler. Say how you think the figure in Question 3 is different from the figure in this question.

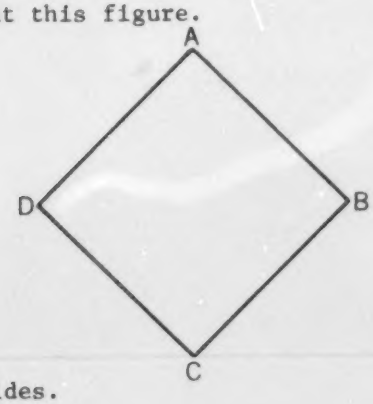
_____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

5. And now look at this figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

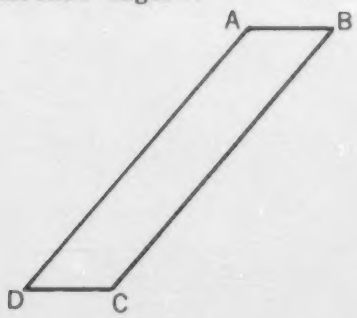
What else do you notice about the sides? _____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

6. Here is another figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

Use your ruler and say what you note about sides AB and DC and AD and BC besides the lengths. _____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

7. Of the last six figures, four were alike and two were different.

   What are the numbers of the four which were alike?

   _____

8. Remember what we said at the beginning of the lesson about describing figures by saying something about sides. Say how you think that the four figures you named in the last question are alike.

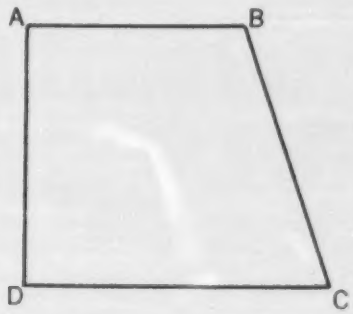
   _____

   _____

   Each of the four figures which are alike is called a parallelogram.

9. The next six figures will help you learn about still another special kind of quadrilateral. It is called a trapezoid. Look carefully at the figures so that you can tell how they are alike and how they are different.

   Here is the first figure.



   Look at it carefully and use your ruler to check the sides, especially sides AB and DC.

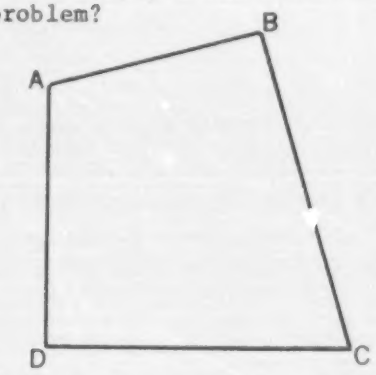
   What do you find? _____

   _____

   Is $\overline{AB}$ parallel to $\overline{DC}$? _____

   Is $\overline{AD}$ parallel to $\overline{BC}$? _____

10. Look at this figure now. Can you see how it is different from the figure in the last problem?



Use your ruler to find out how sides AB and DC in this problem are different from sides AB and DC in the last problem._____

_____

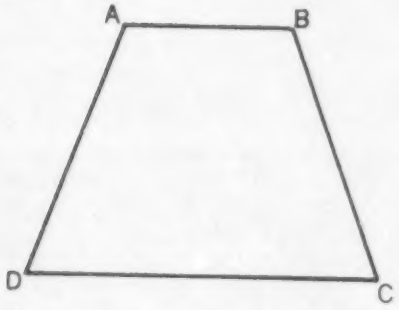
Are they equal in length? _____

What else did you find? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

11. Look at this figure carefully and see how it is like the figure in question 9 and different from the figure in question 10.



Use your ruler again to find out how sides AB and DC in this problem are like sides AB and DC in question 9 and different from sides AB and DC in question 10. Write what you found about sides AB and DC here.

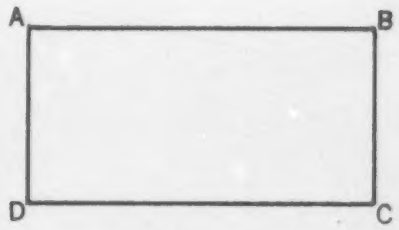
_____

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

12. Here is another figure. This is different from the figure in the last problem.



Can you write here how this figure is like the figure in question 11 and how it is different from it?

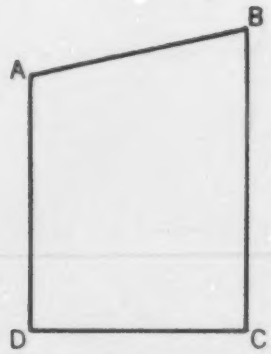
_____

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

13. Now look at this figure.



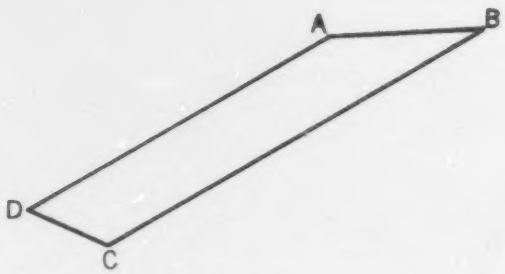
Use your ruler again and find out how this figure is like the figures in questions 9 and 11 and different from the figures in questions 10 and 12. Write what you found here.

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

14. And now look at this figure.



Do you think this figure is like any of the others you just looked at?

_____

Use your ruler if you are not sure. Write here how it is like the figure in question 13.

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

15. Of the last six figures, four were alike and two were different. What are the numbers of the four which were alike?

_____

9, 11, 13, 14

16. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question were alike.

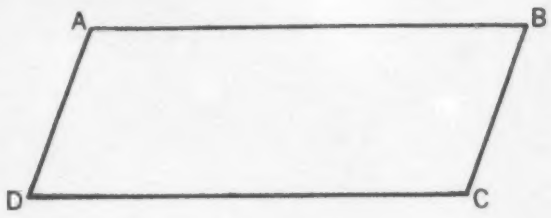
_____

Each had one and only one pair of parallel sides.

Each of the four figures which were alike is called a <u>trapezoid</u>.

17. The first six figures you studied (questions 1 to 6) were to help you learn how to tell whether or not a figure was a parallelogram. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a parallelogram. First, we must be sure you can remember the word parallelogram itself. Repeat it several times to yourself: parallelogram, parallelogram, parallelogram. Now write the word parallelogram here. _____
Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

18. Here is the first figure.



Measure the sides AB and DC.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

What else did you notice about $\overline{AB}$ and $\overline{DC}$? Check again and write what you find out here.

_____

_____

Measure sides AD and BC.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

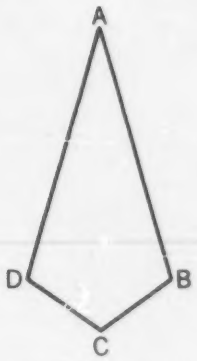
What else did you notice about $\overline{AD}$ and $\overline{BC}$? _____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

19. Look at this figure.



Measure the sides AB, AD, BC, and DC .

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

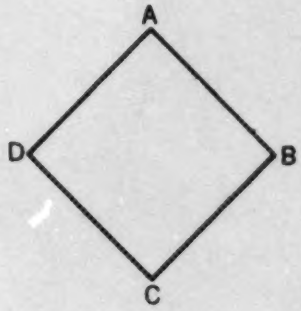
Is $\overline{AB}$ parallel to $\overline{DC}$? _____

How is this figure different from the figure in the last question?

_____

_____

20. Now look at this drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

How is this figure different from the last figure? _____

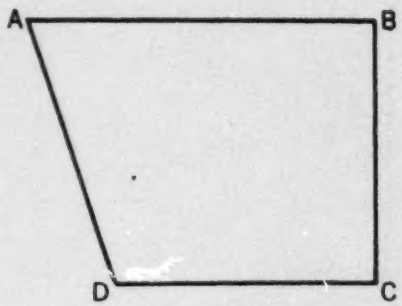
_____

How is this figure like the figure in question 18? _____

_____

_____

21. Here is another drawing.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

Can you see how this figure is different from the figure in question 20? Use your ruler. Say how you think the figure in question 20 is different from the figure in this question.

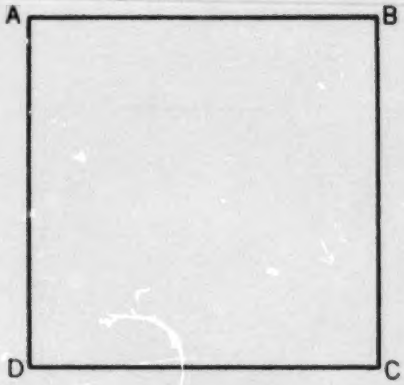
_____

_____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

22. And now look at this figure.



Measure the sides.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

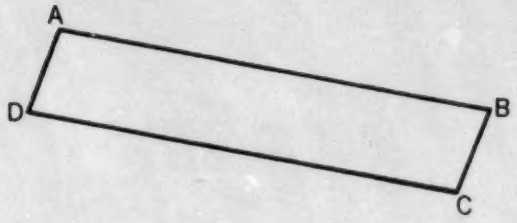
What else did you notice about the sides? _____

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

23. And here is another figure.



Write the lengths of the sides here.

$\overline{AB}$ is _____ inches long.

$\overline{DC}$ is _____ inches long.

$\overline{AD}$ is _____ inches long.

$\overline{BC}$ is _____ inches long.

Use your ruler and say what you notice about sides AB and DC and sides AD and BC besides the length.

_____

_____

24. In the last six examples, four were alike and two were different. What are the question numbers of the four which were alike.

_____

18, 20, 22, 2

25. Remember what we said at the beginning of the lesson about describing figures by saying something about the sides. Say how you think that the four figures you named in the last question were alike.

_____

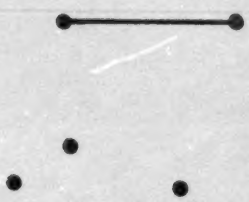
_____

_____

_____

Two pairs of opposite side were equal in length and tw pairs of opposite side were parallel Quadrilateral which have two pairs of opposite sides equal in length and two pairs of opposite sides parallel are called parallelogram

26. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that is not a parallelogram.



---

27. Using a ruler, connect as many points as you need to finish the figure so it is a parallelogram.

---

28. All parallelograms have something special that not all quadrilaterals have. Parallelograms have _____ pair(s) of _____ sides.

_____

_____

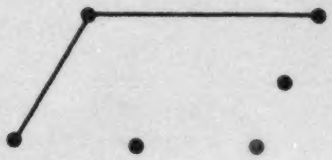
---

29. List all that is needed to completely describe parallelogram.

30. Using a ruler, connect as many points as needed to close the figure so it has 2 pairs of parallel sides.

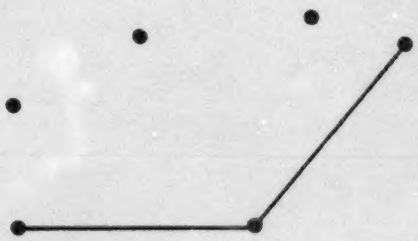
---

31. Using a ruler, complete this figure so that it is a quadrilateral but <u>not</u> a parallelogram.



---

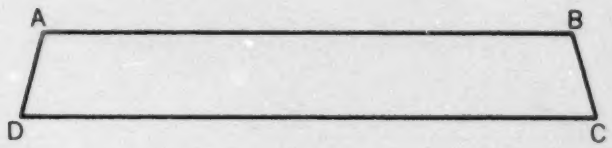
32. Using your ruler, complete this figure so that it <u>is</u> a parallelogram.



33. In questions 9 to 14 there were six figures which you studied to help you learn to tell whether or not a figure is a trapezoid. In case you are not sure, we are going to look at six more figures. These should help you know for sure whether or not a figure is a trapezoid. First we must be sure you can remember the word trapezoid itself. Repeat it several times to yourself: trapezoid, trapezoid, trapezoid. Now write the word trapezoid here. _____

Remember what we said at the beginning of the lesson about describing a figure in terms of its sides and nothing else. Now look carefully at the next six figures. Notice which are alike and how they are alike.

34. Here is the first figure.



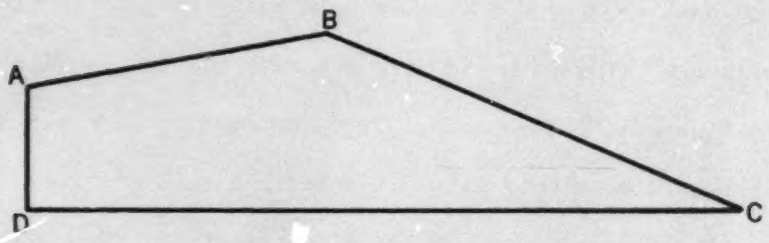
Look at it carefully and use your ruler to check the sides, especially sides AB and DC. What did you find?

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

35. Look at this figure. Can you see how it is different from the figure in the last problem?



Use your ruler to find out how sides AB and DC in this problem are different from sides AB and DC in the last problem.

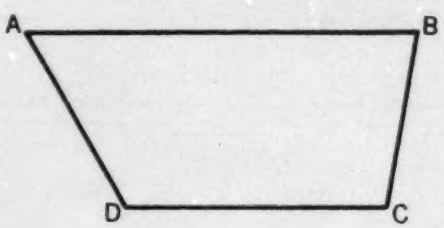
_____

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

36. Look at this figure carefully and see how it is like the figure in question 34 and different from the figure in question 35.

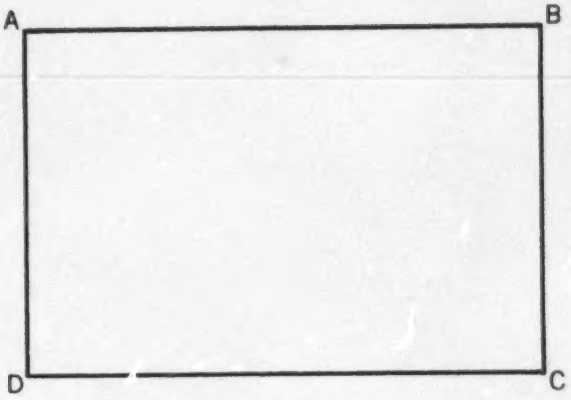


Use your ruler.

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

37. Here is another figure.



Is $\overline{AB}$ parallel to $\overline{DC}$? _____

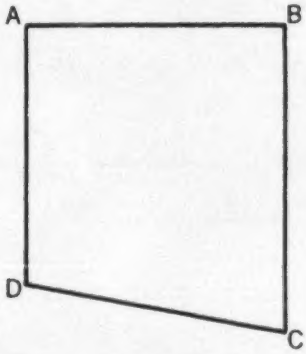
Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Can you write here how this figure is like the figure in the last question and how it is different from it?

_____

_____

38. Now look at this figure.



Use your ruler again and find out how this figure is like the figures in questions 34 and 36 and different from the figures in questions 35 and 37. Write what you found here.

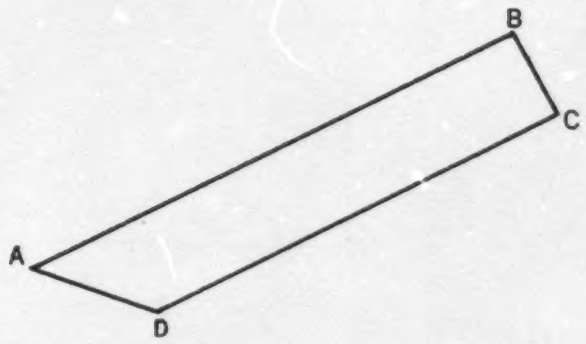
_____

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

39. And now look at this figure.



Do you think this figure is like any of the others you just looked at?

_____

Is $\overline{AB}$ parallel to $\overline{DC}$? _____

Is $\overline{AD}$ parallel to $\overline{BC}$? _____

Write here how this figure is like the figure in the last question.

_____

_____

40. Of the last six figures, four were alike and two were different. What are the numbers of the four which were alike?

_____

34, 36, 38, 39

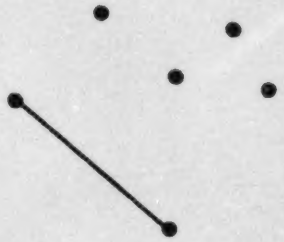
41. Remember what we said at the beginning of the lesson about describing figures by saying something about their sides. Say how you think that the four figures you named in the last question were alike.

_____

_____

Each had one pair and only one pair of parallel sides. A quadrilateral with one and only one pair of parallel sides is called a trapezoid.

42. Using a ruler, connect as many points as you need to finish the figure so it <u>is</u> a trapezoid.



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43. All trapezoids have something special that not all quadrilaterals have. Trapezoids have _____ pair(s) of _____ sides.

_____

_____

---

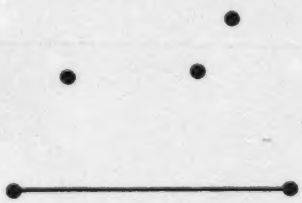
44. List all that is needed to completely describe <u>trapezoid</u>.

---

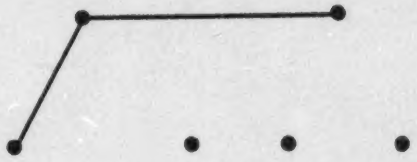
45. Using a ruler, connect as many points as needed to close the figure so it has only 1 pair of sides parallel.

---

46. Using a ruler, connect as many points as you need to finish the figure to make a quadrilateral that is <u>not</u> a trapezoid.



47. Using a ruler, complete this figure so that it is a quadrilateral but <u>not</u> a trapezoid.



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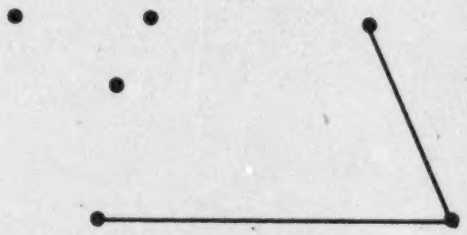
48. Using a ruler, complete this figure so that it <u>is</u> a trapezoid.



TESTS OF GEOMETRY KNOWLEDGE: FORM JS

Name _____

School _____

Grade _____ Date _____

TESTS OF GEOMETRY KNOWLEDGE:
Form JS

INSTRUCTIONS: Use only the special pencil.
Make neat, heavy marks.
Keep your place on the answer sheet.
Make only one mark for each question.
If you change your mind about an answer, erase the first mark completely.

Example 1

1. Which of these figures is a circle?

a. b. c. d.

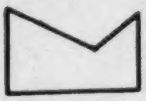
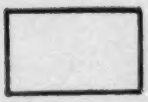
Example 2

2. How many sides does this figure have?

a. 1
b. 2
c. 3
d. 4

1 T F A B C D E 2 T F A B C D E

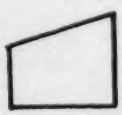
1. Which figure is <u>not</u> a quadrilateral?

a. b.  c. d. 

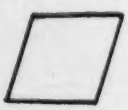
2. <u>All</u> rhombuses have:

a. 4 right angles
b. only 1 pair of parallel sides
c. no parallel sides
d. all sides of equal length

3. Which figure has 2 pairs of parallel sides?

a. b.  c. d.

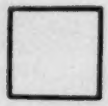
4. Which figure is a trapezoid?

a.  b. c. d.

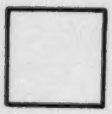
5. <u>All</u> quadrilaterals are:

a. plane closed figures with opposite angles equal
b. plane closed figures with 5 sides
c. 4-sided closed plane figures with 4 right angles
d. 4-sided closed plane figures

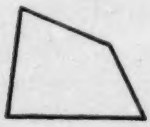
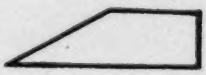
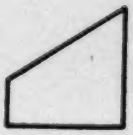
6. Which figure is <u>not</u> a rhombus?

a.  b. c. d.

7. Which figure is a parallelogram?

a.  b. c. d.

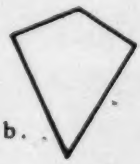
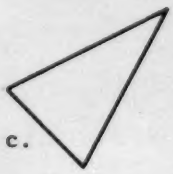
8. Which figure is <u>not</u> a trapezoid?

a.  b.  c.  d.

9. <u>All</u> quadrilaterals have:

a. no sides of equal length
b. no sides parallel
c. closed sides
d. 2 sides of equal length

10. Which figure has all sides of equal length?

a. b.  c.  d.

11. Which figure is a parallelogram?

a. b. c. d.

12. All trapezoids are:

a. plane open figures with 4 sides

b. plane closed 4-sided figures with opposite sides of equal length

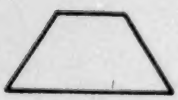
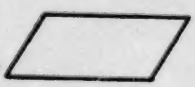
c. plane closed 4-sided figures with only 1 pair of parallel sides

d. plane closed 4-sided figures with 2 pairs of parallel sides

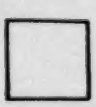
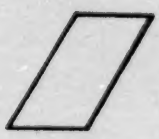
13. Which figure is <u>not</u> a quadrilateral?

a. b. c. d.

14. Which figure is a rhombus?

a.  b.  c. d.

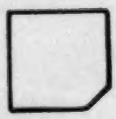
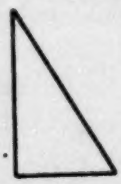
15. Which figure is <u>not</u> a parallelogram?

a.  b. c. d. 

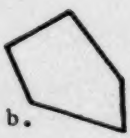
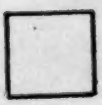
16. <u>All</u> trapezoids have:

a. 2 sides of equal length
b. 2 pairs of parallel sides
c. all sides of equal length
d. 1 pair of parallel sides

17. Which drawing has 4 sides?

a. 
b. 
c.
d.

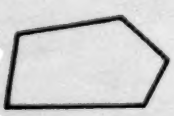
18. Which figure is a rhombus?

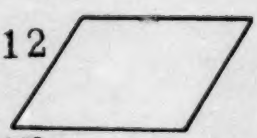
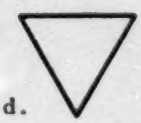
a.
b. 
c. 
d.

19. <u>All</u> parallelograms are:

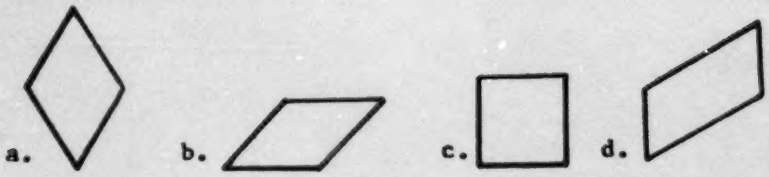
a. quadrilaterals with all sides of equal length
b. quadrilaterals with 2 pairs of opposite sides of equal length
c. quadrilaterals with all sides of unequal length
d. quadrilaterals with only 1 pair of parallel sides

20. Which figure is a quadrilateral?

a. 
b

c. 
d. 

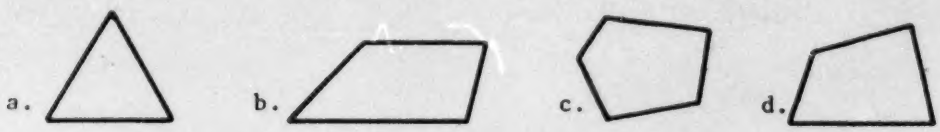
21. Which figure is <u>not</u> a rhombus?



22. <u>All</u> parallelograms have:

a. all sides of equal length
b. no sides parallel
c. only 1 pair of parallel sides
d. 2 pairs of parallel sides

23. Which figure has only 1 pair of parallel sides?

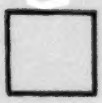


24. Which figure is a quadrilateral?

25. <u>All</u> rhombuses are:

a. quadrilaterals with 4 right angles
b. quadrilaterals with only 1 pair of sides of equal length
c. parallelograms with all sides of equal length
d. parallelograms with all angles equal

26. Which figure is <u>not</u> a parallelogram?

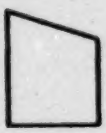
a. 

b.

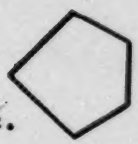
c.

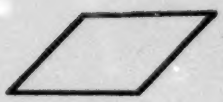
d.

27. Which figure is a trapezoid?

a. 

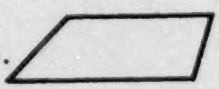
b.

c. 

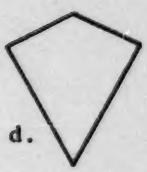
d. 

28. Which figure is <u>not</u> a trapezoid?

a.

b. 

c.

d. 

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